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# NUCLEAR SCIENCE ABSTRACTS

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UNITED STATES ATOMIC ENERGY COMMISSION
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Volume 17, Number 17, September 15, 1963

# NUCLEAR SCIENCE ABSTRACTS

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Volume 17, Number 17 September 15, 1963

# NUCLEAR SCIENCE ABSTRACTS

## GENERAL AND MISCELLANEOUS

**28588** (AECL-1791) ANNUAL REPORT, 1962-63. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 33p.

The annual report of Atomic Energy of Canada Limited for the fiscal year ended March 31, 1963, together with the financial statements and the auditor's report are presented. Information is given of the nuclear power program, Chalk River Nuclear Laboratories, Whiteshell Nuclear Research Establishment, Commercial Products Division, international co-operation, administration, and highlights of the year. (N.W.R.)

**28589** (EUR-236.e) THE ORGANIZATION OF AND LITERATURE ON NUCLEAR RESEARCH IN THE SOVIET UNION. G. Reichardt (European Atomic Energy Community). May 1963. 21p.

An outline is presented of the present state of information and documentation in the Soviet Union and its innumerable information sources in the field of nuclear research are discussed. An account is given of the difficulties encountered in the coordination and evaluation of the amount of information available. Note is also made of the fact that only a small percentage of this information reaches the Western scientist, the reasons for which are covered in detail. A possible solution to the problem, designed to provide the Western research scientist with better access to specialized Soviet literature, is provided. (auth)

**28590** (NP-12957) KERNENERGIE IN SUID-AFRIKA. (Nuclear Energy in South Africa). A. J. A. Roux (Pretoria. Univ.). 1962. 41p.

Four lectures on nuclear energy are presented. The fundamental processes of fission, essential reactor components, and various types of research reactors are discussed. The first reactor to be installed by the Atomic Energy Board is described with emphasis on core composition, the control system, and the experimental facilities. Building layout is indicated in several illustrations. The use of uranium as fuel in reactors is considered after the general requirements for nuclear fuels are summarized. The occurrence of natural reserves of uranium, the mining of these reserves, and investigation into the treatment of the crude uranium concentrate in South America for the production of nuclear fuel are covered. The problems of specialized scientific staff training for nuclear research and development were examined. The functions of the different types of engineer in this context are sketched and consideration is given to the particular approach which should be adopted in training engineers. (auth)

**28591** (NP-12958) SURVEY OF ACTIVITIES, 1962. (Norway Institutt for Atomenergi, Kjeller and Norway. Institutt for Atomenergi, Halden). 26p.

Research and development progress at the Institutt for Atomenergi is reported. Topics covered include: organization, Jeep, Nora Project, Jeep-II, Halden Reactor Project, reactor dynamics, ship propulsion studies, chemistry, metallurgy, isotope production, neutron physics, the Netherlands'-Norwegian Reactor School, safety work and health physics, technical information service, and international cooperation. (M.C.G.)

**28592** (PAEC(A)IN-631) NUCLEAR ENERGY IN THE PHILIPPINES. An Annotated Bibliography. (Philippines. Atomic Energy Commission, Manila). Jan. 1963. 46p.

An annotated bibliography is presented consisting of 132 references dealing with nuclear energy applications in the Philippines. The included articles are indexed by subject, author, and year of publication from 1917 to 1962. (B.O.G.)

**28593** (PAEC(A)IN-632) THE PHILIPPINE ATOMIC ENERGY PROGRAM. AN OUTLINE OF STATUS AND FUTURE ACTIVITIES. Florencio A. Medina and Pacifico N. Aprieto (Philippines. Atomic Energy Commission, Manila). [1963]. 14p.

The status and activities of the Philippine Atomic Energy Commission are outlined. Information is included on administrative and legislative aspects, development and research, technical aspects, and summary of major problems. (N.W.R.)

**28594** (FTD-TT-62-202) ON NEW RESULTS OF SOVIET SPACE EXPLORATION. Erno Nagy. Translated from Nepszabadsag, Dec. 24, 1961. 7p. (AD-286126)

Findings on the nature of the earth's atmosphere; the effects, nature, and range of the radiation belts; the effects of space radiations on plants and animals; and the distribution of cosmic radiation are qualitatively summarized. (D.C.W.)

**28595** PLANNING THE ROLE OF NUCLEAR ENERGY IN ELECTRICITY PRODUCTION. A. A. De Boer and E. M. J. A. Sassen. Euratom Bull., No. 2, 4-11(June 1963). (In English)

Factors that influence the development of nuclear energy for the production of electricity are considered. The most economic method of integrating nuclear power plants into the grid, the long-term planning required to approach the most desirable structure at a given future date, and the influence exerted by factors other than costs on the extent to which nuclear energy must be stimulated are discussed. Anticipated trends in nuclear power plants are also considered. (C.E.S.)

**28596** ECONOMIC RECOVERY AFTER NUCLEAR WAR. Ronald Ridker. Nucl. Inform., 5: No. 6, 1-12 (May 1963).

Whether or not a modern community (St. Louis as an example) could survive a nuclear attack even if it were not directly hit is discussed. The area extending to a 100-mile radius from the center of St. Louis is also included. Supplies such as food, clothing and shelter, water, electricity, coal, natural gas, petroleum products, and medical facilities and supplies are considered. The intervals following nuclear attack are also discussed. (P.C.H.)

**28597** BALL LIGHTNING AS NEW WEAPON. Wojskowy Przeglad Lotniczy, No. 2, 72-5(Feb. 1963).

Ball lightning is proposed as a defensive or offensive weapon on the basis of a theory of ball lightning, according to which plasma balls are generated by powerful electric discharges in the atmosphere if the discharge frequency is close to the radiofrequency (of the order of several Mc). From calculation the average diameter of a charge of ball lightning has to be 40 to 120 cm, since waves of this length produce resonance. It is pointed out that by concentrating a beam of 10-cm radio waves in a small area, it would be possible to generate artificial lightning, which in turn should provoke electrodeless discharges in gases in the form of a spherical plasmoid. (OTS)

**28598** ATOMNAYA ENERGIYA I PUTI EE PRAKTICHESKOGO ISPOL'ZOVANIYA. (Atomic Energy and Ways to its Practical Applications.) K. V. Astakhov. Moscow, Publishing House for Naval Defense, 1957. 280p.

Basic principles in the concept of atomic energy are presented. Matter and energy transformations, atomic and nuclear structure, stable and unstable nuclei, and the nature of nuclear forces are discussed. The reactions that take place in atomic and hydrogen bombs and the effects of their explosion are considered. Nuclear reactors and the utilization of the power developed in them are also discussed. (C.E.S.)

# BIOLOGY AND MEDICINE

## General and Miscellaneous

**28599** (TID-18979) MUTATION RATES AT SPECIFIC AUTOSOMAL LOCI IN DIFFERENT SPECIES OF DROSOPHILA. Six-Months Report, due April 30, 1963. Aloha Hannah-Alava (Turku, Finland, Univ.). Contract IAEA 31-US. 9p.

Preliminary results of genetic studies on Drosophila melanogaster are presented. Analysis of data on 46 males mated singly, sequentially, and daily after the 7th day, or until the male died, for 24 days after treatment with 3000 r x radiation, indicated that induced crossovers occurred in one brood as pseudoclusters, and that clusters beginning the 12th or 13th day after irradiation and initial mating may continue for a number of broods. (C.H.)

**28600** ROENTGENOLOGIC DEMONSTRATION OF INTRAHEPATIC HEMATOMA FOLLOWING LIVER BIOPSY: REPORT OF A CASE. M. B. Ozonoff (San Francisco General Hospital). Am. J. Digest. Diseases, 7: 848-9 (Sept. 1962).

The possible advantages and attendant hazards of using Thorotrast to demonstrate the presence of liver hematoma are weighed. The longevity of $ThO_2$ radiation constitutes an undesirable hazard to the patient in the use of Thorotrast. It is retained in the reticuloendothelial system generally and in the liver by the Kupffer cells. Tumors of the liver may be produced as a result. In general, the remote hazard of its use should be well understood and it should not be used as a routine procedure. It is suggested that the age of the patient be considered. The risks of carcinogenesis may be small in the patients compared to the risk of exploratory surgery. (H.H.D.)

**28601** ORIGIN OF FIBROBLASTS IN WOUND HEALING: AN AUTORADIOGRAPHIC STUDY OF INHIBITION OF CELLULAR PROLIFERATION BY LOCAL X IRRADIATION. Hermes C. Grillo (Massachusetts General Hospital, Boston). Ann. Surg., 157: 453-67(Mar. 1963).

Skin wounds of guinea pigs were locally exposed to 750-r doses of x rays at various times after wounding to inhibit cellular proliferation in attempts to determine the origin of cells involved in wound repair. Cellular proliferation was followed by the incorporation of thymidine-$H^3$ as seen by autoradiography. It was concluded that the effect on fibroblast proliferation resulted from influences applied to cells resident in the tissues of the wound area at the time of wounding. A large proportion of fibroblasts would seem to originate from cell precursors present in resting local mesenchymal tissues. Opposing previous theory, in the present experiment no excessive proliferative attempts by fibroblasts were observed adjacent to nonproliferating capillaries. Thus, while capillary inhibition did occur, and it is probable that, in time, fibrous precipitation might result locally from the activity of arrested fibroblasts, there was no evidence to suggest a limitation of recruitment from the vascular system in the area as a result of irradiation effect on capillaries. (H.H.D.)

**28602** ISOTOPIC TRACER STUDIES ON THE BIOSYNTHESIS OF DEOXYRIBOSE IN THE RAT. Dolly Ghosh and I. A. Bernstein (Univ. of Michigan, Ann Arbor). Biochim. Biophys. Acta, 72: 1-9(May 28, 1963). (In English)

The biosynthesis of deoxyribose was studied with $NaHC^{14}O_3$ as a tracer in normal adult, starved adult, normal newborn, thiamine-deficient adult and tumor bearing rats and in Yoshida ascites-tumor cells. Comparisons of the tracer patterns in ribose and deoxyribose isolated from the nucleic acids of skin and liver suggest that in young tissues the formation of deoxyribose may occur by direct reduction from ribose or via an intermediate common to ribose. The data obtained from the livers of young adults do not support this concept unless the pattern of $C^{14}$ in the ribose which is the precursor of deoxyribose, is different from that of the ribose isolated from the RNA. The presence of an ascitic tumor in the young adult seems to influence pentose metabolism in the host liver. (auth)

**28603** INTRACELLULAR LOCALIZATION IN RAT LIVER OF AN INHIBITORY FACTOR OF IN VITRO SYNTHESIS OF DEOXYRIBONUCLEIC ACID. R. Goutier and I. Bologna (Centre d'Etude de l'Energie Nucléaire, Mol, Belg.). Biochim. Biophys. Acta, 72: 40-7(May 28, 1963). (In French)

The synthesis of DNA in the presence of aqueous extracts of regenerating rat livers was measured. Suspensions of microsomes from normal liver powerfully inhibit this incorporation. The observed inhibition was not due to a hydrolysis of primer DNA by alkaline DNAase nor to a dephosphorylation of the precursors by phosphatases. Microsomes prepared from regenerating livers have a smaller inhibitory power than that of normal liver microsomes. (auth)

**28604** ON THE EXTIRPATION OF A CERVICAL THOROTRASTOMA, WITH A CONTRIBUTION TO THE CLINICAL FINDINGS IN LATE NECK INJURY FROM THOROTRAST. K. Ungerrecht (Universitats-Poliklinik fur Hlas-, Nasen-, and Ohrenkranke, Munich). HNO, 9: 339-49(Nov. 1961).

The case history of a woman who developed a benign cervical tumor containing large deposits of $ThO_2$, 20 yr after carotid angiography with Thorotrast, is described and 14 similar cases reported in the literature are reviewed. The thorotrastoma in the present case consisted largely of a cellular fibrous tissue containing giant cells and $ThO_2$ deposits free in the tissue and within histiocytes. The course of development of tissue reactions to Thorotrast is described. (H.H.D.)

**28605** FISSION PRODUCTS AND THE DAIRY COW. 5. THE RADIOTOXICITY OF IODINE-131. R. J. Garner, B. F. Sansom, H. G. Jones, and L. C. West (Agricultural Research Council Field Station, Compton, Berks, Eng.). J. Comp. Pathol. Therap., 71: 71-84(1961).

Pathologic responses were recorded in 24 cows orally given total doses of 1.4 to 140 mC $I^{131}$, calculated to deliver radiation doses of 1500- to 290000-rad doses to the thyroid gland. In all 4 animals receiving 10 mC $I^{131}$ daily, edema developed in the region of the thyroid gland 11 days after feeding was initiated. The swelling was transient and had disappeared completely in another 5 days. Within 1 to 2 weeks of withdrawal of $I^{131}$ the animals became lethargic and apathetic, rising only to feed. Except in one animal, the milk yield was not initially affected. No significant changes were observed at any time in the formed constituents or physical properties of the blood, or in any of the normal chemical constituents determined, other than the plasma protein-bound iodine (PBI). In all animals receiving 10 mC daily, there was a sudden and marked increase

in PBI 12 to 14 days after dosing began. In animals sacrificed ~2 months after high dosage $I^{131}$ administration, no pathological changes were found in any organs or tissues other than in the thyroid gland. Microscopically, almost no functional thyroid tissue remained. Extensive necrosis of the epithelial elements was most pronounced in the central portion of the lateral lobes where persisting connective tissue stroma was the only evidence of the normal follicular pattern. The milk yield in all surviving animals that received a total of 140 mC $I^{131}$ was considerably lower and the time of lactation shorter than for the last lactation period before administration of the isotope. It was concluded that the minimum radiation dose needed to damage the bovine thyroid gland sufficiently for general effects on the animal to manifest themselves is of the order of 100,000 rad. Assuming that 20% of ingested $I^{131}$ was accumulated in the thyroid gland, the amount that would have to be eaten over a short period to deliver a thyroid radiation dose of 100,000 rad is about 90 mC. It was calculated that, in the case of a nuclear reactor accident, the deposition of $I^{131}$ on pastures would have to exceed 240 $\mu C/m^2$ to allow the cow to ingest this dose. (TCO)

**28606** DETERMINATION OF CORONARY BLOOD FLOW INDEX BY EXTERNAL SCINTILLATION DETECTION. Ismael Mena, Pablo Thomsen, and Leslie R. Bennett (Catholic Univ., Santiago de Chile and Univ. of California, Los Angeles). J. Nucl. Med., 4: 259-76(July 1963).

Normal subjects and patients with coronary disease were studied by simultaneous detection of the passage of a radioactive bolus through the heart, the brachial or femoral artery, and the brain. In normal subjects the arterial and brain curve downslopes are similar to each other and are steeper than the heart downslopes. The delay in the heart downslopes is due to coronary radioactivity interposed between the heart cavities and the detector. In coronary patients the three downslopes are similar. Values were established for the coronary flow index (CFI) in normal males, in normal females, and in patients with myocardial infarction. In seven normal individuals with abnormally low CFI subsequent determinations after administrations of reserpine were normal. No modification was recorded in infarct patients. These clinical observations are in accord with the experiments in animals and theoretical analyses which demonstrate that the ratio of these downslopes is an index of coronary blood flow. (auth)

**28607** PRODUCTION AND USE OF IODINE-125. Paul V. Harper, Warren D. Siemens, Katherine A. Lathrop, and Harold Endlich (Argonne Cancer Research Hospital, Chicago and Univ. of Chicago). J. Nucl. Med., 4: 277-89(July 1963).

The procedures for production of $I^{125}$ by neutron activation of xenon in relatively pure form are outlined. The pertinent dose calculations for the use of $I^{125}$ in thyroid and liver scanning are presented, and the advantages of $I^{125}$ from the point of view of long half life, increased tolerable isotope dosage, reduced radiation dosage, and improved scanning resolution are illustrated. While many of these advantages cannot be fully exploited without special detectors, they appear to be great enough to justify the substitution of $I^{125}$ for $I^{131}$ in many instances using available commercial detection equipment. (auth)

**28608** A QUERY INTO THE USE OF TRACER DOSES OF I-131. Murray L. Janower (Massachusetts General Hospital, Boston). J. Nucl. Med., 4: 290-5(July 1963).

Twenty-four major hospital centers dispensed 2100 tracer doses of I-131 for purposes of evaluation of the thyroid gland from May 1 to 28, 1961. The most frequent procedure was an uptake study. The average patient was a 50 year old female; only 32 children were included. The doses administered are described. It is shown that they represented a small fraction of the total $I^{131}$ available to the hospital. (auth)

**28609** LOCALIZATION OF BRAIN TUMORS WITH THE POSITRON SCINTILLATION CAMERA. Hal O. Anger and Alexander Gottschalk (Univ. of California, Berkeley). J. Nucl. Med., 4: 326-30(July 1963).

The use of a positron scintillation camera in the localization of brain tumors after administration of $Ga^{68}$ is described. The radiation dose to the patient is much lower than with other methods of brain tumor localization and the pictures are obtained in a relatively short time. Gallium-68 has a half life of 68 min and decays by positron emission 85% of the time. (C.H.)

**28610** EFFECTS OF RAT STRAIN, STILBESTROL AND TESTOSTERONE AND THE OCCURRENCE OF HEMORRHAGIC DIATHESIS IN RATS FED A RATION CONTAINING IRRADIATED BEEF. Om P. Malhotra, A. V. Nalbandov, E. F. Reber, and H. W. Norton (Univ. of Illinois, Urbana). J. Nutr., 79: 381-8(Mar. 1963).

Experiments were designed to investigate the difference between 2 strains of rats (Holtzman and Sprague-Dawley), and the effects of stilbestrol and testosterone on the ocurrence of hemorrhagic diathesis. The rats were fed ground beef exposed to 5.58 Mrad doses of $Co^{60}$ $\gamma$ radiation. Mortality was 58% for Sprague-Dawley rats, significantly higher than the 22% found for Holtzman rats. The average prothrombin rate, 50 for Sprague-Dawley rats at the end of the third week was significantly lower than 83 for Holtzman rats, prothrombin rates being expressed as 1000/sec. Sprague-Dawley rats were significantly less resistant to hemorrhagic disease than Holtzmann rats. Stilbestrol completely prevented hemorrhages and subsequent deaths, but testosterone increased both. The effect of testosterone was independent of growth. Stilbestrol decreased the prothrombin rates slightly and testosterone decreased them significantly. Stilbestrol decreased body weight gains, its effect being greater on Holtzman than on Sprague-Dawley rats. Testosterone increased growth in orchiectomized rats but had no effect on feed intake. Stilbestrol decreased the weight of seminal vesicles, prostates, and testes. Testosterone increased the weight of seminal vesicles and prostates but decreased the weight of testes. Stilbestrol was more potent than testosterone in inhibiting the secretion of hormones by the pituitary. Estrogen administration did not affect the prothrombin rate of rats fed a ration containing 2.79-Mrad irradiated beef, but increased it in those that received the 5.58-Mrad irradiated beef. It is suggested that estrogen overcame defective coagulation, but had no effect when the prothrombin rate was normal. (TCO)

**28611** CONTINUOUS MEASUREMENT OF THE SPECIFIC ACTIVITY OF EXPIRATORY CARBON DIOXIDE OF AN ANIMAL AFTER ADMINISTRATION OF CARBON-14 LABELED COMPOUNDS. ISOTOPIC EQUILIBRIUM STUDY. F. Chevallier, M. Briere, F. Serrell, and M. Cornu (Centre d'Études Nucléaires, Saclay, France). J. Physiol. (Paris), 54: 701-10(Sept.-Oct. 1962).

Techniques and apparatus for continuously recording the activity of expired $C^{14}O_2$ are described. Air is passed through a cotton filter to remove dust and through soda lime to remove $CO_2$ into the metabolism chamber. Expired gases are pumped from the chamber through a $CaCl_2$ moisture trap, a recording cell, and a final soda-lime

filter. The cell is equipped with an ionization chamber 1400 $cm^3$ in volume, which is connected to a continuously recording apparatus. $CO_2$ concentration is measured by an infrared spectrophotometer. The chamber can detect as little as 0.04 m$\mu$C, corresponding to ~100 disintegrations per minute, and a maximum of 0.43 $\mu$C. In practice, the flow rate is 1 to 2 l/min, giving $CO_2$ concentrations of 0.1 to 0.6%, for the rat as an experimental subject. The technique is illustrated by measurements made with rats up to 5 hr after intraperitoneal injection of 20.6 $\mu$C sodium acetate-1-$C^{14}$. During the 1st 2 hr, 83.5% of the administered radioactivity was expired as $CO_2$, and 5.8% during the next 3 hr. Experiments on the isotopic equilibrium of acetate in rats are also described. Rats were allowed periodic access to acetate-1-$C^{14}$-containing water and food in a specially constructed chamber and expiration of $C^{14}O_2$ was continuously recorded. The tracings obtained showed a series of peaks when the rats were allowed 5-min access to the water every 2 hr and to the food every 3 hr. (H.H.D.)

**28612** EXPERIENCES WITH $NaI^{131}$ INJECTED INTO THE MYOCARDIUM AS AN ESTIMATE OF CORONARY BLOOD FLOW. Irving M. Madoff and William Hollander (Boston Univ.). J. Thorac. Cardiovasc. Surg., 42: 755-63 (Dec. 1961).

A new method for measuring coronary blood flow was developed on the basis of the concept that the rate of disappearance of an ion injected into a tissue is a function of blood flow. The rate of removal of $NaI^{131}$ injected into the myocardium was observed in relation to the integrity of coronary blood flow. The procedure was carried out on anesthetized dogs during open thoracotomy and on human subjects, with and without coronary artery disease, either percutaneously or during open thoracotomy for intrathoracic disease. Disappearance of $NaI^{131}$ from heart muscle was measured continuously by externally monitoring the site of injection using a scintillation detector. In anesthetized dogs the disappearance of $NaI^{131}$ was extremely rapid. The rate of removal decreased as a coronary artery was progressively narrowed and stopped completely following total occlusion of the artery. In human subjects without coronary artery disease the disappearance of $NaI^{131}$ was also rapid and comparable to the findings in the animal studies. In patients with coronary artery disease the removal of $NaI^{131}$ was markedly impaired. The variations in the rates of disappearance of $NaI^{131}$ from the myocardium of individual patients with coronary artery disease appears to be related to a change in the site of injection; different portions of myocardium are apparently perfused at different rates. (H.H.D.)

**28613** APPROACHES FOR COMBINED RADIATION AND CHEMOTHERAPY. Malcolm A. Bagshaw (Stanford Univ., Calif.). Laval Med., 34: 124-33(Jan. 1963). (In English)

From Symposium on Radiosensitivity, Laval Univ., Quebec, Sept. 1962.

Experimental data are reported showing the synergistic injurious effects of radiation and metabolic inhibitors on tumor cells, and application of the principle to clinical problems of tumor therapy is described. In vitro studies were conducted with mammalian cell cultures treated with the fluorinated pyrimidine analogues, fluorouracil, and 5-fluorodeoxyuridine, which are not incorporated but act as inhibitors of de novo thymidylic acid synthesis, preventing the conversion of uracil to thymine and thus interrupting DNA anabolism. Fluorouracil changed the slope of the x-ray dose-log survival curve when the drug was present in the medium throughout the period of incubation following irradiation. This was interpreted as potentiation by virtue of inhibition of the repair of DNA damaged by irradiation. It was also demonstrated that, in the in vitro system with hamster ovary cells, considerable radio-sensitization occurred when the cells were pretreated with 5-bromodeoxycytidine. The x-ray dose-log survival curve for hamster cells grown prior to irradiation for 5 days with $10^{-4}$ and $10^{-3}$M 5-bromodeoxycytidine showed that at $10^{-4}$M the slope ratio is 1.74, while at $10^{-3}$M it is 2.56. Pretreatment of the hamster cells with 5-bromodeoxycytidine produced a higher degree of sensitization than pretreatment with either 5-bromodeoxyuridine or 5-iododeoxyuridine. A further increase in radiosensitization was shown when the cells were incubated with both 5-fluorouracil and 5-bromodeoxycytidine prior to irradiation. Although radiosensitization can be clearly demonstrated in vitro for many purine and pyrimidine analogues, their therapeutic exploitation remains to be demonstrated. Treatment of 5 cancer patients with x rays and chemotherapeutic agents is described; in each case the radiation effect was enhanced by the drug used, although tumor regression was not complete. (TCO)

**28614** TRITIUM CONTENT OF ANTARCTIC SNOW. S. P. Shen, S. A. Korff, and H. A. C. Neuburg (New York Univ., New York). Nature, 199: 60-1(July 6, 1963).

Three samples of snow collected in the Antarctic during 1960 and 1961 were analyzed for tritium content. Results are compared with published data on the tritium content of Antarctic and Southern Hemisphere precipitation. A sample collected in 1961 had 5 times the tritium levels for 1941, and a doubling of the tritium level was noted during 1956 and 1960. The contribution of tritium in stratospheric fallout is discussed. (C.H.)

**28615** SULPHUR ISOTOPIC VARIATIONS IN NATURE. PART 9. A RECOMPARISON OF THE NEW ZEALAND SULPHUR STANDARD WITH THE METEORITIC SULPHUR STANDARD. J. R. Hulston and Jeanette Beauchamp (Nuclear Sciences Inst., Lower Hutt, N. Z.). New Zealand J. Sci., 6: 157-62(Mar. 1963).

A comparison was made of the New Zealand $S^{32}/S^{34}$ working standard and Troilite from the Canyon Diablo meteorite. Conversion formulas for previous New Zealand results are given, and the cause of discrepancies in previous measurements is discussed. (C.H.)

**28616** INVESTIGATION OF INTENDED RADIATION THERAPY OF MELANOMA AND THE CHROMAFFIN SYSTEM BY SELECTIVE $H^3$ INCORPORATION AFTER DOSES OF $H^3$-LABELED DOPA. Klaus Hempel and Maria Deimel (Universität, Cologne). Strahlentherapie, 121: 22-45(May 1963). (In German)

The possibilities for radiotherapeutic application of $H^3$-labeled 3,4-dihydroxyphenylalanine (DOPA) were investigated. DOPA in the animal organism is the precursor of melanine and the catecholamines. The integral radiation burden of the different organs of the normal mouse and the melanoma-mouse was calculated using the distribution with time of the $H^3$-activity in the organs. The $H^3$-distribution in adrenal and melanoma was determined autoradiographically. In the adrenal medulla $H^3$-concentration was 50 to 100 times greater than in all other organs. In that case, therapeutically effective radiation doses of about 25 000 rad can be obtained with $H^3$-DOPA, while the radiation burden of the other organs did not exceed 400 rad. However, in the melanoma radiation doses were considerably higher than in the other parts of the organism, but were not sufficient enough for radiotherapy of the tumor. (P.C.H.)

**28617** MEASUREMENT OF INTEGRAL DOSES FOR DEEP-THERAPY RADIATION. Alfred Schaal (Siemens-Reiniger-Werke AG, Ger.). Strahlentherapie, 121: 75-82 (May 1963). (In German)

The dependency of the water depth on the area dosage was measured in a water phantom using a large flat ionization chamber. The integral dose was obtained by integration of the area dose curve in case of classical-, $Co^{60}$-, and ultrahard x rays as well as for high-energy (34 Mev) electrons. Measured and calculated integral dosage agreed well. By means of the area dosage curve the importance of the integral dose in regard to the general radiation effect is discussed, comparing different kinds of radiation. (auth)

**28618** PROCEEDINGS OF THE FOURTH NATIONAL CANCER CONFERENCE, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINNESOTA, SEPTEMBER 13 TO 15, 1960. Philadelphia, J. B. Lippincott Company, 1961. 786p.

One hundred articles on cancer are included; 5 are abstracted in NSA. The articles not included in NSA include discussions on various types of cancer and their treatment. (P.C.H.)

**28619** RADIATION AS AN ETIOLOGIC FACTOR. Arthur C. Upton (Oak Ridge National Lab., Tenn.). p.63-9 of "Proceedings of The Fourth National Cancer Conference." Philadelphia, J. B. Lippincott Co., 1961.

The role of radiation in carcinogenesis is surveyed briefly. One of the most important facts that throw new light on the role of radiation in the neoplastic process is the observation that radiation can induce certain types of cancer through effects on the host without acting directly on the cells it causes to undergo neoplasia. (P.C.H.)

**28620** RADIATIONS, NATURAL AND MAN-MADE. Arthur C. Upton (Oak Ridge National Lab., Tenn.). p.153-60 of "Proceedings of The Fourth National Cancer Conference." Philadelphia, J. B. Lippincott Co., 1961.

Pertinent facts pertaining to radioinduced cancer are reviewed. What is known about the induction of the disease is discussed in relation to the possible cancerogenic hazards of environmental radiation in the world around us. Weighed against the hazards of cancer induction, the value of radiation as an experimental tool in cancer research and its growing usefulness in the diagnosis and the treatment of malignancy are noted. (P.C.H.)

**28621** THE CHANGING PLACE OF RADIATION THERAPY IN THE TREATMENT OF CANCER. Franz Buschke (Univ. of California, San Francisco). p.183-6 of "Proceedings of The Fourth National Cancer Conference." Philadelphia, J. B. Lippincott Co., 1961.

A re-evaluation of the respective indications for surgery and radiotherapy in the treatment of many forms of cancer where it is essential to take into consideration not only the statistical 5-year salvage rate, but also the price paid for the results in morbidity and in functional impairment is presented. Special attention is given to the treatment of epidermoid carcinoma of the oral mucosa (gingiva, bucca, floor of mouth, palate, and pillar). (P.C.H.)

**28622** IN VIVO RADIOAUTOGRAPHY IN THE RECOGNITION OF GASTRIC CANCER. Norman B. Ackerman, A. S. McFee, B. T. Santoro, D. B. Shahon, and Owen H. Wangensteen (Univ. of Minnesota, Minneapolis). p.461-74 of "Proceedings of The Fourth National Cancer Conference." Philadelphia, J. B. Lippincott Co., 1961.

The method and experience with in vivo balloon radioautography of the stomach are presented. The test is based upon the increased uptake of $P^{32}$ by malignant tissues. Some case studies are cited. (P.C.H.)

**28623** IRRADIATION AS A CAUSATIVE FACTOR IN THYROID CANCER. Milton T. Edgerton (Johns Hopkins Univ., Baltimore). p.661-2 of "Proceedings of The Fourth National Cancer Conference." Philadelphia, J. B. Lippincott Co., 1961.

A review is presented on the effects of radiation on the incidence of thyroid cancer. It was concluded that even light doses of radiation to the neck region of children may result in thyroid carcinoma. Evidence continues to appear in support of this association. (P.C.H.)

**28624** LE RADIAZIONI E I LORO EFFETTI. (Radiations and Their Effects). Mario Ageno. Turin, Paolo Boringhieri, 1962. 142p.

Four lectures, presented as an introduction to the radiobiology course at the postgraduate school of the Istituto de Genetica of the University of Pavia, serve as the basis of this book on radiations and their effects. The topics discussed are questions of methods in radiobiology, energy aspects of radiations, interactions of radiation with matter, and alterations produced by radiations in irradiated substances. The purpose of the book is to give in a systematic and coherent fashion the basic data necessary for participants in the course. (J.S.R.)

**28625** DIAGNOSIS AND TREATMENT OF RADIOACTIVE POISONING. Proceedings of the Scientific Meeting held at Vienna, 15-18 October 1962. (International Atomic Energy Agency, Vienna). Proceeding Series. Feb. 1963. 460p. (STI/PUB/65). $9.00; Sch 189; 54s.stg; NF 36; DM 31.50(IAEA).

Twenty papers are included; abstracts were prepared for 15 and 5 were previously abstracted in NSA. Information is presented on counting and sample assay and on radium, strontium, rare earths and ruthenium, and plutonium and other transuranic elements. A separate list of participants is also included. (P.C.H.)

**28626** EXTERNAL COUNTING. J. Vennart (Medical Research Council, Sutton, Surrey, Eng.). p.3-22 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963.

The present position with regard to fixing maximum permissible levels of body radioactivity is reviewed and external methods of detection are discussed in relation to the levels. It was demonstrated that in operational control quite simple detectors will suffice for the majority of radionuclides in the body, which can possibly be measured by external counters. However, in a few cases very high sensitivity equipment is required, primarily because the permissible levels are low but also, since they are retained in the body for very long periods of time, it is necessary to have early warning that they are being absorbed. A few examples are discussed in detail in order to show the limits of detection that are possible with high sensitivity whole-body counters. Perhaps the most important role that can be played by external counters is in studies of the behavior of radioactive materials in the body and in observations of the changing radioactivity of contemporary man. Examples of the types of investigation that are possible are given. (auth)

**28627** THE PROBLEMS AND METHODS OF SAMPLE ASSAY. B. A. J. Lister (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). p.23-40 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

The need for a bioassay program, difficulties in interpreting the results, setting of investigation levels, and problems of planning, including frequency of sampling and size of sample are discussed. Consideration is given to the need for fecal sampling both after accidental intake and as a routine measure. A brief survey is given of current analytical methods for specific radionuclides. (P.C.H.)

**28628** HUMAN DATA ON RADIUM UPTAKE, RETENTION, AND ELIMINATION. E. Oberhausen (Universität, Saarlandes, Hamburg, Ger.). p.47-55 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

An evaluation of data on radium uptake, retention, and elimination by man is presented. (P.C.H.)

**28629** EXCRETION OF RADIUM IN RELATION TO DIETARY INTAKE. R. C. Turner (Royal Cancer Hospital, London). p.69-86 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

Comprehensive measurements of the $Ra^{226}$ contents of more than 200 common foods and 100 of the principal supplies of drinking water in Great Britain were used to compare the mean intakes of radium per person from these sources in a number of occupational groups as well as among the populations of various regions of the country. In spite of the wide range of activities present in foods, the mean intakes show little variation among the groups, the values lying between 2 and 3 pC per person per day. The drinking waters in Britain have radium contents differing by factors of up to 250 to 1, but in the majority of cases the absolute levels are so low relative to those present in the staple foods that the mean intakes from water represent only 5 to 6% of the mean total amounts of radium ingested by each individual. Only in one exceptional area of the country, representing less than 1% of the total population, is it possible for the daily intakes from water to exceed those from food. Measurements of fecal excretion from the normal dietary intake have shown that in the case of young adults, the average level of $Ra^{226}$ excreted in this way is 2 to 2.5 pC/day. Measurements of the daily intakes and fecal excretions of a young child, over a period of 33 days, indicated that the retention of radium during periods of active bone growth may be as high as 10% or even more. (P.C.H.)

**28630** ATTEMPTS TO INFLUENCE THE UPTAKE, RETENTION, AND EXCRETION OF RADIOSTRONTIUM IN ANIMALS. A. Nelson (Research Inst. of National Defence, Sundbyberg, Sweden). p.95-117 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

The effects of isotopic and non-isotopic carriers, chelating and other agents on a single dose of radiostrontium were surveyed. A decreased retention was observed after some agents. The effect is, however, limited and dependent on an early administration of the agent. Secondly, the effects of dietary constituents on the body burden of radiostrontium are discussed. The dietary effect of calcium appears to be a complicated problem and besides calcium many other constituents in the diet influence the absorption of radiostrontium. It was concluded, however, that increased dietary calcium under defined conditions would reduce the ultimate body burden of radiostrontium. (P.C.H.)

**28631** UPTAKE, RETENTION, AND EXCRETION OF STRONTIUM IN MAN. G. E. Harrison (Medical Research Council, Harwell, Berks, Eng.). p.119-29 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

The absorption of strontium from the gastrointestinal tract is discussed in relation to the diet and the different components of a bread and milk diet. A brief review is given of results obtained by using chelators and diets high in calcium in order to decrease the strontium absorption. The ratios of strontium to calcium in the different body compartments for adult man are discussed. The results of recent experimental work on normal man on a constant diet are reviewed with particular reference to the urinary excretion and the retention of $Sr^{85}$ contained in the experimental diet. The endogenous fecal excretion is also derived. The results are compared with those obtained from a single intravenous injection of radioactive strontium. For all the subjects the retention was obtained from whole-body counting using a pulse height analyser. The retention of strontium in the skeleton was analyzed and it is postulated that there are at least three degrees of binding of radioactive strontium with bone. In particular the retention several months after the dose and the relationship of the retention to the radiation dose to the skeleton from $Sr^{90}$ are discussed. A formula is proposed for the evaluation of body retention of a radioactive dose of strontium from the radioactivity excreted in the urine. (auth)

**28632** TREATMENT OF RADIOSTRONTIUM UPTAKE IN MAN. V. Volf (Inst. of Industrial Hygiene and Occupational Disease, Prague). p.131-44 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

In short-term experiments on rats the passage of radioactive strontium through the intestinal wall was modified by oral treatment using barium sulfate and normal calcium phosphate. However, in rats on a diet containing barium sulfate there was no change in the absorption of $Sr^{90}$ given in drinking water. It was concluded that this substance could be of value in first-aid treatment only. In two cases of slight internal contamination following accidental $Sr^{90}$ nitrate inhalation, barium sulfate (Skiabaryum Spofa) was administered orally within 10 and 30 min after the inhalation of $Sr^{90}$. The effectiveness of the treatment was tested in model experiments on rats performed under similar conditions as in the accidents. More recently, experiments on similar lines were carried out on several cancer patients, in order to investigate further possibilities of first-aid treatment following acute internal radiostrontium contamination in man. (auth)

**28633** REMOVAL OF RADIOSTRONTIUM FROM MAN. H. Spencer (Edward Hines, Jr., Hospital, Hines, Ill.). p.145-55 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

Studies on the metabolism of radiostrontium in man were carried out under controlled metabolic and dietary conditions. The relatively short-lived radioisotope $Sr^{85}$ was used as the tracer. Single tracer doses of $Sr^{85}$ were administered intravenously and orally and the plasma levels and urinary and fecal excretions were determined. The main pathway of $Sr^{85}$ excretion was found to be via the kidney irrespective of the route of administration of the tracer. An average of 20% of the orally administered dose was absorbed from the intestine and approximately 50% of the absorbed dose was excreted in urine in 12 days by a large number of persons. Studies in which tracer doses of $Sr^{85}$ and $Ca^{45}$ were given simultaneously by the oral route indicated the preference of the body for $Ca^{45}$ absorption and for $Sr^{85}$ excretion, the $Ca^{45}/Sr^{85}$ absorption ratio being 2.6:1. $Sr^{85}$ studies carried out during low and high calcium intake in the same persons revealed that the high calcium intake did not lead to any

significant change of $Sr^{85}$ absorption in most of the persons studied. Since the urinary $Sr^{85}$ excretion was found to parallel the urinary calcium excretion, enhancement of urinary calcium was induced by different agents that increased the calciuria. Intravenously infused stable calcium and strontium, orally administered ammonium chloride given singly or in combination with intravenously infused calcium, and certain chelating agents were effective in removing radiostrontium from man as late as two to four weeks after the injection of the tracer. Also, $Sr^{90}$ balance studies were carried out in 12 young normal volunteers. No radioisotope was given in this study. The results obtained in $Sr^{90}$ studies were similar to those obtained with $Sr^{85}$. (auth)

**28634** RARE EARTHS AND RUTHENIUM: METABOLISM AND REMOVAL FROM THE MAMMALIAN BODY. A. Catsch and D. Seidl (Kernforschungszentrum, Karlsruhe, Ger.). p.191-205 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

An attempt was made to corroborate previous findings on the effectiveness of chelates in removing an internally deposited radiometal in rats. It was found that $Ru^{106}$ is chelated by different compounds, in particular by BATE. A marked removal of internally deposited $Ce^{144}$ can be achieved by appropriate chelating agents, even when treatment is started with delay with compounds such as DTPA and TTHA. Experimental data are presented on the toxicity of DTPA and the dependence of its effectiveness on dose, time, and mode of administration. This permits recommendation of a treatment schedule that guarantees a maximum therapeutical effect and simultaneously avoids harmful side-effects of the chelator. (P.C.H.)

**28635** SOME FACTORS INFLUENCING THE ABSORPTION, RETENTION, AND ELIMINATION OF RUTHENIUM. R. S. Bruce (Medical Research Council, Harwell, Berks, Eng.). p.207-24 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

The nature and extent of the hazard from radioruthenium depend not only on the circumstances of contamination but also on the physical and chemical state of the ruthenium. $Ru^{106}$ administered orally as the dioxide is absorbed from the gastro-intestinal tract to a negligible extent when it is in a particulate form with carrier present; but when given as a colloid in the absence of carrier, uptake is similar to that which follows administration of the chloride (3-5%). Nitrato-derivatives of nitrosyl ruthenium may be absorbed to an even greater extent (an average of 13% is absorbed by rabbits). Absorption by rats, which are not fasted, is complete within one hour of an intragastric dose. The limited period of absorption may be explained in terms of the rate of gastric emptying and combination of ruthenium with the contents of the gut. When rats are fasted overnight before the ruthenium is administered, absorption is increased threefold and continues over a longer period. Nitrato derivatives of nitrosyl-ruthenium, in contrast to other compounds tested, react with the wall of the upper small intestine where up to 20% of an oral dose may be retained for several hours. Although the chemical state of ruthenium influences the degree of absorption, the subsequent distribution is not greatly affected. Approximately half of the absorbed ruthenium is excreted in the urine during the first 24 hr. After one month, 5 to 20% of the absorbed fraction is retained with a long biological half life. The ruthenium is distributed throughout the body with the concentrations in the various organs seldom differing by a factor of more than five, though the distribution within a single tissue is not necessarily uniform. The concentration in the kidney, which is the main route of excretion, is high. Consideration of the behavior of ruthenium in blood serum helps to explain the processes involved in its distribution and retention. (P.C.H.)

**28636** CLINICAL STUDIES ON PERSONS INJURED BY RADIOACTIVE MATERIALS. T. Kumatori and K. Miyoshi (National Inst. of Radiological Sciences, Chiba-Shi, Japan). p.253-72 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

Twenty-three Japanese fishermen were exposed to radioactive fallout from the detonation of a thermonuclear device in the Pacific in 1954. Their fishing boat at the time of detonation was ninety miles east from the explosion center. A review is presented on: the chemical composition and radiochemical analysis of the falling material; early symptoms and signs, hematological observations, liver damage, and disturbances of spermatopoieses; urinalysis of the patients, external counting performed on the fishermen, and biochemical analysis; and the treatment given and the follow-up of the cases. (auth)

**28637** ACTUAL PROBLEMS OF THE DISTRIBUTION OF RADIOISOTOPES AND THE KINETICS OF THEIR EXCRETION. Yu. I. Moskalev. p.287-306 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In Russian)

The character of the distribution of radioisotopes (Cs, Rb, Sr, Ca, Ba, Ra, Ce, La, Pm, Sb, Te, Pu, Y, Zr, Ru, Nb, and Po), depending on the way and rhythm of their administration, the physiological state of the organism, and physico-chemical factors are discussed. It was shown that 10 to 18% of some radioisotopes ($Cs^{137}$, $Nb^{95}$, $Zr^{95}$, $Y^{91}$, $Ru^{106}$, and $Ce^{144}$) were retained in the lungs when administered by inhalation. Cesium and especially strontium are absorbed from the lungs extremely rapidly, while the absorption of ruthenium, cerium, and particularly plutonium is slow. The type of distribution of radioactive isotopes does not depend on the species of the animal, as is sometimes the case with the kinetics of their elimination. The rate of $Ce^{144}$ removal from canine and feline liver is exceedingly low, unlike that in rats, mice, guinea pigs, and rabbits. The amount of the deposited material and the kinetics of its elimination in case of $Sr^{90}$ and $Pu^{239}$ are determined by the rhythm and duration of the isotope intake. From the data presented it can be seen that the results of experiments with a single injection do not always characterize the kinetics of the accumulation of the isotope in cases of its continuous administration. Chelate compounds (EDTA, hexametaphosphate–HMP), isotope and non-isotope carriers, and the pH of the original solution change the distribution of hydrolysed elements (cerium, yttrium) and do not affect the type of distribution of elements that are highly-soluble in water. When the pH of the original solution increases, the amount of cerium and yttrium deposition also increases in the organs containing much reticulo-endothelial elements (liver, spleen) and decreases in the skeleton and kidneys. The acceleration of the $Ce^{144}$ and $Y^{91}$ excretion caused by the chelate compounds (EDTA, HMP) is delayed with the increase of the pH of the original solution. (auth)

**28638** SOME ASPECTS OF CHELATION CHEMISTRY. H. J. Heller (J. R. Geigy AG, Basel). p.347-73 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

Notions used in chelation chemistry are defined and the

possibilities of the experimental recognition of complex formation are described. A review of the quantitative aspects of chelation is given, especially under biological conditions. Some rules concerning the general behavior of various metal ions and organic ligands in chelation phenomena are presented and the specificity problem is discussed. The present status of the decontamination of the main fission products, (rare-earth metals and strontium), with the aid of complexing agents was analyzed from a chemical point of view. (auth)

**28639** DIAGNOSIS AND TREATMENT OF A LOCAL AND AFTERWARDS GENERALIZED PLUTONIUM CONTAMINATION. J. Lafuma (Centre d'Études Nucléaires, Fontenay-Aux-Roses, France). p.381-6 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In French)

During an accident a technician's hands were contaminated with $Pu^{239}$ nitrate. The contamination on the left hand alone, measured with an x detector, was close to 60 $\mu$C. The contamination was brought down to 15 $\mu$C by a first decontamination carried out under a local anaesthetic; several contamination zones were localized by scanning. A surgical operation, done under an Esmach band with x and $\alpha$ detectors, reduced the contamination from 15 to 5 $\mu$C, the hands' functions being integrally preserved. A new zone of activity was localized by a second scan, and a second operation reduced internal contamination in the hand to 2 $\mu$C. It has not been possible to localize the activity but it is kept under regular supervision. Parallel with the surgical decontamination, an internal decontamination with DTPA was undertaken. Blood, urine and feces were sampled immediately after the accident and their activity was measured. Afterwards, urine samples were taken daily; blood and fecal samples were taken during each period of treatment. All the measurements indicate that DTPA is extremely effective in the case of internal contamination by $Pu^{239}$. It also appears that the percentage of blood plutonium eliminated by the kidney varies with time. The percentage increases, indicating that the plutonium is carried in the blood under different ionic or colloidal forms that are cleared in different degrees by the kidneys. It would accordingly appear that the activity in the urine does not faithfully reflect the internal contamination. (auth)

**28640** MEDICAL MANAGEMENT OF RADIOACTIVELY CONTAMINATED WOUNDS. H. Foreman (Univ. of Minnesota, Minneapolis). p.387-411 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (In English)

The treatment of burns contaminated with radioactivity is discussed. Data that might be used as a basis for medical judgement are included. In addition to the usual measures involved in the medical management of wounds, the presence of radioactivity requires further considerations. These involve decontamination of the surface area surrounding the wound, evaluation of the radioactivity contained in the wound, excision of the contaminated tissue, and treatment with a regimen utilizing the intravenous administration of a suitable chelating agent, followed by urinary or fecal assay for a period of time. (P.C.H.)

**28641** DEVICE FOR A RADIATION PLANT COMPRISING RAY GENERATOR AND TREATMENT BED. Rolf Wideroee and Hermann Egger (to Brown, Boveri & Cie AG). U. S. Patent 3,090,868. May 21, 1963. Priority date July 4, 1958, Switzerland.

An apparatus for radiation therapy is patented, which consists of a ray generator and a treatment bed for irradiating parts of the body of the patient with the beam at various angles of incidence. The source of rays can be pivoted by a motor about a horizontal axis passing through the source. The bed is on a chassis, which can be moved along a horizontal track perpendicular to the axis of rotation of the generator. The ray generator is connected to the treatment bed by an arm and a pivoted joint, which cause the bed to be moved back and forth as the generator pivots. Vertical movement of the generator is controlled by a servo mechanism. Details of the design are described and illustrated. (M.P.G.)

## Biochemistry, Nutrition, and Toxicology

**28642** (CISE-95) RADIOCHEMICAL STUDIES FOR RADIOACTIVITY DETERMINATIONS IN MARINE PLANKTON. E. Cerrai, L. Pelati, and C. Triulzi (Centro Informazioni Studi Esperienze, Milan). May 1963. 39p.

Procedures are described for the radiochemical analysis of marine plankton and other biological materials. Experimental results are included. (C.H.)

**28643** (LF-4) THE TISSUE DISTRIBUTION AND EXCRETION OF CESIUM-137 FOLLOWING INHALATION—PRELIMINARY DATA FOR RATS. Technical Progress Report. J. F. Stara and R. G. Thomas (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Apr. 1963. Contract AT(29-2)-1013. 25p.

Data were obtained for the distribution-excretion pattern of cesium in rats over a period of 102 days following inhalation exposure. Three groups of 20 rats each were exposed to aerosols generated from solutions of carrier-free, 1 and 8 per cent cesium chloride which contained cesium-137 as a tracer. Urine and feces of all rats were collected daily until sacrifice, and the time-tissue distribution patterns were determined after death. All measurements were made by gamma counting with sodium iodide crystals. Cesium chloride, being extremely soluble, was absorbed rapidly from the lungs and the digestive tract and the amount initially deposited in lung was reduced to less than 1 per cent during the first post-exposure day. The initial deposition in the lung was dependent on the aerosol particle size which was varied by the addition of the cesium chloride carrier; more lung deposition occurred with the smallest particle sizes. After the first day, the skeletal muscle and skin contained the largest amounts of this fission product but several organs such as lung and kidney had approximately the same concentrations. Because of lack of significant amounts of radioactivity at the later sacrifice times, no definite decision could be made regarding the choice of one critical organ for greatest radiation effect. Total excretion of $Cs^{137}$ displayed an early rapid phase followed by two successively slower phases, presumably the entire pattern being fit by an exponential function. These three phases, obtained from the whole body retention curve, can be resolved into half-lives of approximately 0.6, 7.0, and 18.7 days. The importance of interspecies comparison in obtaining parameters for estimating hazards to man is discussed, using cesium metabolism as an example. (auth)

**28644** (JPRS-19937(p.29-37)) CONCERNING THE ACCUMULATION OF RADIOSTRONTIUM BY HYDROPHYTES AND DETRITUS. A. L. Agre and M. M. Telitchenko. Translated from Byul. Mosk. Obshchestva Ispytatelei Prirody, Otd. Biol., 68: 133-7(1963). (OTS-63-31160 (p.29-37))

The effectiveness of hydrophytes and detritus in de-

activating reservoir waters contaminated by fallout fission products was investigated. The species of hydrophytes investigated were those known to play an active role in the transfer of mineral substances in reservoirs. These include green algae, blue-green algae, diatoms, mosses, and some higher plants. Experimental solutions prepared with settled tap water spiked with various amounts of $Sr^{90}$ were used. A species difference in $Sr^{90}$ accumulation was demonstrated. Data are presented graphically. About 80% efficiency in deactivation of solutions was obtained with detritus dispersed in the solutions. The accumulation of $Sr^{90}$ by both hydrophytes and detritus took place basically according to the laws of sorption. Results indicate that the ability of both hydrophytes and detritus to accumulate $Sr^{90}$ can be utilized in the deactivation of water containing $Sr^{90}$. (C.H.)

**28645** RADIOAUTOGRAPHIC STUDY OF THE INCORPORATION OF RADIOACTIVE PHOSPHORUS BY BENIGN AND MALIGNANT TUMORS OF THE UTERUS. Alberto Zacutti and Giovanni Turchetti (Università, Pisa, Italy). Arch. Ostet. Ginecol., 66: 303-13(May-June 1961).

Attempts were made to develop a diagnostic method that would distinguish malignant tissue from benign tumors and normal tissue, based on the differential uptake of $P^{32}$-phosphate as determined by radioautography. Patients were injected intravenously with 1.5 $\mu$C $P^{32}$ per kg body wt 24 to 48 hr prior to laparotomy and removal of the uterus. Normal endometrium showed a moderate $P^{32}$ uptake and cervical mucosa slightly greater uptake. Fibromyomas showed a higher uptake than normal myometrium and could be distinguished on the radioautograph on this basis as a circumscribed area. Cervical carcinoma showed a markedly higher uptake than normal tissue or benign tumors, as did an adenocarcinoma of the body of the uterus. The results indicate that a high rate of uptake of $P^{32}$ by nucleic acids of rapidly proliferating cancer cells makes it possible to distinguish these cells from normal or benign tumor cells. (H.H.D.)

**28646** INVESTIGATIONS ON THE ELIMINATION OF RADIOACTIVE IODINE BY THE THYROID DURING STRESS IN THE RAT. L. Asch (Faculté de Médecine, Strasbourg). Compt. Rend. Soc. Biol., 157: 363-5(1963). (In French)

The effects of the thyrotropic hormone on the elimination of radioactive iodine by the thyroid was studied in male rats subjected to paw amputation after the injection of the radioactive iodine. Some of the animals received thyrotropic hormone intramuscularly. The animals were sacrificed 54 and 72 hrs after the injection of the radioactive iodine. The results show a sharp decrease in the liberation of radioactive iodine during surgical stress. Under the action of the hormone, the thyroid elimination of the radioiodine between the 54th and 78th hrs is very strongly increased both in the samples and in the animals subjected to surgery. The thyroid activated by the thyrotrope hormone seems capable of producing hormones from its iodine reserves without recourse to the circulating iodides. (J.S.R.)

**28647** THE MINERAL CONTENT OF THE LUNG IN CHRONIC BERYLLIOSIS. G. W. H. Schepers (E. I. du Pont de Nemours & Co., Wilmington, Del.). Diseases Chest, 42: 600-7(Dec. 1962).

Tissues from 58 cases of suspected chronic berylliosis were subjected to spectrographic and histologic study. The results were compared with analyses of lung tissues of 187 human subjects and 316 animals experimentally exposed to various dusts, fumes, and chemicals. Be was demonstrable in lung in 20 of the 58 cases. The values for 22 elements, identified in these 20 cases in which Be also was present, are presented. Certain trace elements, normally present in lung tissue, were not demonstrable in these cases, and Na and K concentrations were decreased. All other values were increased from 2 to 150 times. Selective deviations from the normal values found in 30 cases of sarcoidosis are also recorded. Direct or inverse relation between the excessive presence of Be and that of other elements was demonstrable. Zn was present in excessive quantities in only 7 of these 20 cases; in the remaining 13 cases Zn was not demonstrable. This finding is in harmony with the experimental observation that Zn is eluted from pulmonary tissue during exposure to $BeF_2$. Mn was elevated in all instances. (H.H.D.)

**28648** SOME OBSERVATIONS IN $X_1$ AND $X_2$ OF VICIA FABA L. AFTER TREATMENT WITH DIFFERENT MUTAGENS. Jan Sjodin (Swedish Seed Assoc., Svalof, Sweden). Hereditas, 48: 565-86(1962).

Mutagens were observed after treatment of dried seeds with x rays (2000–10000 r), neutrons (66–1056 rad), ethylene imine (EI), and ethyl methane sulfonate (EMS). Germination ability of the treated seeds was fairly independent of dosage whereas the percentage of emerged and surviving plants decreased with increasing doses. There was a clear difference in fertility between control and treated material but only small differences between different doses of treatment. A description is given of mutations observed in $X_2$, concerning pods, leaves, flowers, seeds, and some physiological characters. The mutagenic effect of x rays was about 4 times and of EMS about 10 times that of EI. The occurrence of chlorophyll-deficient spots on the lower leaves was one of the most typical reactions to the mutagens. The spots consisted of clearly defined groups of light green cells, unevenly distributed over the leaf surface. The structure of the leaf was often changed, especially thickening. The vegetation point was often disturbed and anomalous leaf shapes common. Often the apical leaves showed a mosaic color, probably due to uneven distribution of chlorophyll. Changes in the structure of the pods were also found, with constrictions between the seeds, and hard and somewhat shrunken pods. Another type had long narrow pods. In both types the number of seeds was the same as in the normal type. The most striking flower mutants were those with a change in color from the normal white with violet and brownish black stripes. (TCO)

**28649** INCORPORATION OF PHOSPHORUS-32 INTO NUCLEIC ACIDS DURING EMBRYONIC DEVELOPMENT OF BARLEY. Chong W. Chang (Michigan State Univ., East Lansing). Nature, 198: 1167-9(June 22, 1963).

The rates of incorporation of $P^{32}$ into RNA and DNA were studied by autoradiography in different embryonic stages of barley. The total amount of incorporated $P^{32}$ increased during the embryonic development. The $P^{32}$ incorporation rate in DNA decreased gradually as the growth rate slowed down. The results indicate that RNA turnover in slow or nongrowing tissue is still relatively large. (D.L.C.)

**28650** INCREASED IODINE IN MILK AS A COUNTERMEASURE FOR IODINE-131. F. W. Lengemann (New York State Veterinary Coll., Ithaca). Nature, 198: 1217-18 (June 22, 1963).

Possible addition of iodine salts to the cow's diet or to the milk in order to reduce the $I^{131}$ uptake by the thyroid gland is discussed. Experiments are reported in which four cows were fed $I^{131}$ and then fed 2 to 8.5 g stable iodide/day. The feeding of iodide caused the $I^{131}$ secreted in the milk to fall at a rate of 13.5% per g added iodide.

Thyroid counts on the cows indicated that iodide feeding caused the half life of thyroid $I^{131}$ to decrease. The advantages of addition of iodide to the cow's diet and of direct addition to the milk are discussed. (D.L.C.)

**28651** INVESTIGATION IN RATS OF THE QUESTION OF THE PASSAGE OF RADIOACTIVE COMPOUNDS USED FOR BRAIN TUMOR DIAGNOSIS TO RAT FETUSES AND SUCKLINGS. PART II. PASSAGE OF THE 6.4-day $Bi^{206}_{83}$ BY LACTATION TO SUCKLINGS AND COMPARATIVE HALF LIFE DETERMINATIONS. F. Mundinger and R. Sander (Universität, Freiburg i. B.). Nucl. Med., 3: 204-13 (1963). (In German)

The transfer of the heavy metal 6.4-day isotope $Bi^{206}$ was studied in lactating rats and sucklings. Bi was transferred to the suckling in small amounts via the mother's milk. The maximum Bi content of individual sucklings was reached at the end of the first day of life, amounting to 0.5 to $1.0 \times 10^{-3}$ of that incorporated by the mother rat and to an average tissue concentration of 13/1000 (mother rat = 1). There was no accumulation of Bi in the new-born. Half life determinations showed that, during the period of lactation and, particularly, during gestation, the retention of Bi, as compared to control values, was prolonged in the mother, so that the total effective cumulative incorporated doses during these periods were increased by between one-half to four times their value. (auth)

**28652** EFFECT OF ALUMINUM ON UPTAKE AND TRANSLOCATION OF PHOSPHORUS$^{32}$ BY PERENNIAL RYEGRASS. P. J. Randall and P. B. Vose (Welsh Plant Breeding Station, Aberystwyth, Wales). Plant Physiol., 38: 403-9(July 1963).

Low levels of aluminum ($1.85 \times 10^{-4}$ M) increased the total content and concentration of stable phosphorus in both roots and shoots of 8 week old perennial ryegrass plants. High levels ($18.5 \times 10^{-4}$ M) depressed the total phosphorus but increased the concentration, a reflection of the overall reduction in growth. Low levels of aluminum whether given as a pretreatment during the growth period or during the 4-hour uptake period greatly increased the short term uptake of $P^{32}$. Higher levels of aluminum reduced the uptake. Similar patterns were obtained for both $4.5 \times 10^{-4}$ M and $22.5 \times 10^{-4}$ M P uptake solutions. Potassium cyanide caused a marked inhibition of aluminum-induced phosphorus uptake into the root. In the absence of aluminum, $5 \times 10^{-4}$ M 2,4-dinitrophenol increased transport to the shoots, but with aluminum there was no increase. Manganese sulfate stimulated phosphorus translocation to the shoots. It is concluded that the aluminum-induced increase in phosphate uptake is largely a metabolic process, although precipitation effects on the root cannot be ruled out. A mechanism based on the known stimulation by aluminum of the reduction of cytochrome is postulated for the increase in uptake. On the basis of the effect of 2,4-dinitrophenol, it is suggested that subsequent to the uptake process, phosphorus is bound by aluminum within the plant, thus causing the symptoms of phosphorus deficiency characteristic of aluminum toxicity. (auth)

**28653** EFFECTS ON ZEA MAYS SEEDLINGS OF A STRONTIUM REPLACEMENT FOR CALCIUM IN NUTRIENT MEDIA. William H. Queen, Harvey W. Fleming, and Joseph C. O'Kelley (Univ. of Alabama, University). Plant Physiol., 38: 410-13(July 1963).

When Sr replaced Ca in the nutrient medium, maize seedlings remain alive when seedlings in a Na-replacement for Ca died. In Sr, elongation of roots and shoots was inhibited; however, development of secondary root primordia was stimulated, and differentiated xylem elements appeared near the root apical meristem. In the absence of external Ca in the nutrient medium, Sr, as compared to Na, did not appear to slow down the rate of loss of Ca from seedling roots, nor did it appear to allow for redistribution of Ca from older parts of the root to the root tip. It is concluded that Sr can replace part of the Ca ordinarily required by these seedlings. (auth)

**28654** KINETICS OF Rb ABSORPTION BY EXCISED BARLEY ROOTS UNDER CHANGING Rb CONCENTRATIONS. I. EFFECTS OF OTHER CATIONS ON Rb UPTAKE. T. Tanada (Mineral Nutrition Lab., Beltsville, Md.). Plant Physiol., 38: 422-5(July 1963).

The absorption of $Rb^{86}$ applied as RbCl ($10^{-5}$ M) by excised barley roots (Hordeum vulgare L., var. Atlas 6) was studied by following the concentration changes and the amounts taken up by the roots during its absorption. Rb absorbed by roots was determined after they were washed several times with $2 \times 10^{-5}$ M KCl to remove all Rb adsorbed on superficial sorption sites. In the absence of interfering ions, the quantity of Rb disappearing from the solution agreed with that absorbed by the roots. K ions ($2 \times 10^{-5}$ M) reduced equally both the amount of Rb disappearing from the solution and that taken up by the roots, resulting in both showing good agreement. In the presence of $2 \times 10^{-5}$ M Na, Ca, or Mg ions, however, Rb disappearance and absorption into roots were not only slowed down slightly, but the two quantities did not agree, less Rb was taken into the roots than that disappearing from the solution. A postulate involving a chain of negative sites as possible pathways for cation entry into root cells is given to explain the results. (auth)

**28655** RESOLUTION OF DUAL MECHANISMS OF POTASSIUM ABSORPTION BY BARLEY ROOTS. Emanuel Epstein, D. W. Rains, and O. E. Elzam (Univ. of California, Davis). Proc. Natl. Acad. Sci. U. S., 49: 684-92(May 1963)

The relationship between the rates of absorption of K and Rb by barley roots and the concentration of these ions in the external solution, over the range 0.002 to 50 mM, is predictable on the assumption that two carrier sites bind and transport the ions. One of these operates at half-maximal velocity at a concentration of about 0.018 mM, with very low affinity for Na, the second at about 16 mM, with severe competition by Na. The latter but not the former mechanism is inhibited when $SO_4$ is the anion instead of Cl. (auth)

**28656** SEQUENTIAL REPLICATION OF THE BACILLUS SUBTILIS CHROMOSOME. II. ISOTOPIC TRANSFER EXPERIMENTS. Hiroshi Yoshikawa and Noboru Sueoka (Princeton Univ., N. J.). Proc. Natl. Acad. Sci. U. S., 49: 806-13(June 1963).

An oriented replication of the B. subtilis chromosome was unequivocally demonstrated by isotopic transfer experiments, in which the DNA donor strain (W23) grown in a heavy ($D_2O$-$N^{15}$) medium was transferred to a light ($H_2O$-$N^{14}$) medium. The transfer was made from the stationary growth phase or from the exponential growth phase. Results suggest that there is a longer resting period of chromosome replication in a $D_2O$ medium than in the ordinary medium. In exponentially growing cells in a $D_2O$ medium, the presence of a resting period occupying one half of the generation time was indicated from the frequency ratio of two extreme markers, adenineless and methionineless. (auth)

**28657** DETERMINATION OF THE RADIOIODINE NOT ACCUMULATED BY THE THYROID IN THE NECK REGION FOR INITIAL TEST OF THE THYROID GLAND FUNCTION. Cuno Winkler, Gerhard Kloss, and Gerhard Mentzel (Uni-

versität, Bonn). Strahlentherapie, 121: 141-53(May 1963). (In German)

To determine the radioiodine uptake of the thyroid gland, measurements of the γ radiation that can be detected in front of the neck area were done. The scintillation counter detected not only the radiation that originated in the thyroid gland but also γ rays originating from radioiodine in the blood and in the neck tissue. The influence of the counting rate is more important the shorter the time interval between the application of the radioiodine and the uptake determination. It is shown that as a routine diagnostic test the determination of an individual NAR can be neglected. The knowledge of the average value seems to be sufficient. (P.C.H.)

**28658** IZOTOPY V BIOKHIMII. (Isotopes in Biochemistry (Theoretical Principles, Problems, and Results)). S. Z. Roginskii and S. E. Shnol'. Moscow, Publishing House of the Academy of Sciences, 1963. 380p.

Theoretical principles for the application of isotopes in biochemical research are presented. The solutions of various problems encountered in isotope applications are discussed. Isotope applications in organism migration, photosynthesis, hormone regulation, and steady state conditions are considered. Isotopes and isotopic compounds, kinetics of isotope effects, mechanisms and kinetics of isotope exchange, and their application in biochemistry are discussed. (C.E.S.)

## Fallout and Ecology

**28659** STUDY OF THE TRANSFER OF A RADIOACTIVE ION IN A SLOWLY-MOVING STRETCH OF WATER. P. Bovard, A. Grauby, and Y. Cattan. Bull. Inform. Sci. Tech. (Paris), No. 70, 19-26(Mar. 1963). (In French)

The object of this study is to determine the dispersion of a radioactive ion in a lake, pond, etc., towards the natural surroundings. A micro-pond was constructed in the laboratory from samples taken from a site. After contaminating it, they followed the adsorption on the bottom, on the sides, and on the aquatic plants constituting the micro-site. After two months experiments, measurements were made on the plants and on the containers by countings; the localization of the radioactive ions was carried out by autoradiography of one species. (auth)

**28660** THE USE OF PLANTS IN THE CONTROL OF RADIOACTIVE POLLUTION. J. Gagnaire and A. Chamel. Bull. Inform. Sci. Tech. (Paris), No. 70, 39-44(Mar. 1963). (In French)

The systematic measurement of the radioelement concentration in plant tissues, as well as the study of its variation with time, has become one of the most widely used methods for studying the variations in radioactive contamination of natural surroundings. The phytobiologists contribute to the development of a satisfactory technique by determining accurately the plant species which may be used, the radioelements to be dosed, the methods of extraction, separation, and dosage for the different radioelements, as well as the means of expressing and interpreting the results obtained. (auth)

**28661** THE ACCUMULATION OF SEVEN RADIOISOTOPES BY FOUR DIFFERENT, FRESH-WATER ALGAE. E. A. Gileva (Inst. of Biology, Academy of Sciences, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 149: 1157-8 (Apr. 11, 1963). (In Russian)

The build-up of $S^{35}$, $Co^{60}$, $Sr^{90}$, $Ru^{106}$, $Cs^{137}$, $Ce^{144}$, and $Pm^{147}$ was followed in the single-cell, protococcaceae algae Chlorella vulgaris and Lagerheimia sp., and also in the filamentous types Ulotrix sp. and Vaucheria terrestris. A volume of 0.5 liters of filtered lake water at a pH of 8, containing 10 μC of activity per liter, was contacted with 0.5 grams (dry weight) of the filamentous type of algae, or with enough of the single-cell algae to give 5 to 6 million cells per ml. After 8 to 16 days, samples of the water and of the algae were taken to dryness, and counted on an end-window beta counter. The accumulation coefficients were determined as ratios of the activity in the plant (per 1 gram of dry weight) to the activity in the water (per 1 ml). The data showed that the algae, especially the filamentous type, concentrate activity much more than aquatic life and the higher plants do. Vaucheria terrestris showed high accumulation coefficients for sulfur (a factor of 3875) and ruthenium (a factor of 22,300), while Lagerheimih sp. showed a high accumulation coefficient of 1500 for strontium. The accumulation of activity in the single-cell algae Chlorella vulgis was significantly lower than in the filamentous algae. $S^{35}$, $Sr^{90}$, and $Cs^{137}$ showed the lowest accumulation coefficients. The absorption of $Co^{60}$ and $Ru^{103}$ was moderately high, while the rare earths $Pm^{147}$ and $Ce^{144}$ showed the highest accumulation coefficients. (TTT)

## Radiation Effects on Living Tissues

**28662** (ACRH-19) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Leon O. Jacobson, ed. (Argonne Cancer Research Hospital, Chicago). Mar. 1963. Contract AT(11-1)-69. 125p.

Separate abstracts were prepared for 9 sections of this report. Five sections were previously abstracted and appeared in NSA. (C.H.)

**28663** (ACRH-19(1-22)) USE OF AN ANALOG COMPUTER TO CALCULATE TREATMENT DOSE FOR MULTIPLE FIELDS. L. S. Skaggs and S. D. Savic (Argonne Cancer Research Hospital, Chicago).

Use of an analog computer to summarize the dose distribution of two intersecting beams of radiation has been demonstrated and the method indicated for its extension to three or more beams. These may all intersect at a single point or not. A high degree of flexibility in simulating various types of radiation beams has been demonstrated and possibilities indicated for its extension with a more sophisticated analog computer. Calculations for rotational therapy should also be possible with the latter computer. (auth)

**28664** (ACRH-19(p.23-30)) PREPARATION OF COBALT-60 OF VERY HIGH SPECIFIC ACTIVITY, 300 CURIES PER GRAM, FOR TELETHERAPY. L. H. Lanzl (Argonne Cancer Research Hospital, Chicago).

The preparation of very high specific activity $Co^{60}$ for use in a teletherapy unit is described. The $Co^{60}$ was produced by neutron activation of $Co^{59}$ using a reactor as a source of neutrons. The decay scheme of $Co^{60}$ and procedures used to calculate the specific activity of $Co^{60}$ are included. Factors that determine the design of the collimator and the size and shape of the radiation source are discussed. (C.H.)

**28665** (ACRH-19(p.31-8)) BENZENE EXPOSURE AND APLASTIC ANEMIA FOLLOWED BY LEUKEMIA 15 YEARS LATER. R. L. DeGowin (Argonne Cancer Research Hospital, Chicago).

The case history is presented of a man, exposed to benzene over a 13-year period, who developed aplastic anemia followed 15 years later by subacute myelocytic leukemia. The blood picture over the 15-year period is presented. (C.H.)

**28666** (ACRH-19(p.39-42)) PROTECTIVE EFFECT OF AET ON THE IMMUNE MECHANISM OF X-IRRADIATED MICE. E. L. Simmons and O. Lartigue (Argonne Cancer Research Hospital, Chicago).

Pretreatment with S, 2-aminoethylisothiuronium (AET) reduced mortality of irradiated mice inoculated with leukemia when compared with untreated irradiated controls. AET was more effective when given intraperitoneally than orally. (C.H.)

**28667** (ACRH-19(p.49-53)) PREVENTION OF DEATH IN MICE AFTER LETHAL IRRADIATION OF THE HEAD. R. A. Goepp and F. Fitch (Argonne Cancer Research Hospital, Chicago).

Irradiation of the head of mice with 2000 r without post-irradiation nutritional treatment produced 100% mortality. The feeding of a complete diet through gastrostomy tubes from the 5th to the 20th day after exposure to 2000 r to the head resulted in a 94% survival rate. Results indicate that mice can survive such lethal irradiation if nutrition and hydration are maintained. Observations revealed that radioinduced lingual and palatal ulcerations heal between the 13th and 20th day after irradiation and permit oral ingestion of food and water. (C.H.)

**28668** (ACRH-19(p.54-6)) THE EFFECT OF VITAMIN E ON THE CARCINOGENICITY OF METHYLCHOLANTHRENE. S. L. Haber and R. W. Wissler (Argonne Cancer Research Hospital, Chicago).

Vitamin E, added at the rate of 0.67 to 7.0 grams per kilo of diet, appreciably inhibited the carcinogenic activity of methylcholanthrene in C57 mice. (C.H.)

**28669** (ACRH-19(p.65-70)) PROPERTIES OF THE DNA-DEPENDENT SYNTHESIZED RNA. S. B. Weiss (Argonne Cancer Research Hospital, Chicago).

The mechanism of the polymerization reaction of RNA polymerase in extracts of Micrococcus lysodeikticus was investigated using $P^{32}$-labeled ribonucleic acid as tracer. A reaction scheme for RNA polymerase and a proposed mechanism for complementary RNA synthesis are presented. The data suggest that the RNA product is a faithful copy of the DNA primer and that both strands of the DNA double helix function as templates resulting in the production of complementary RNA chains. Experiments with highly purified preparations of RNA polymerase suggested that synthetic ribopolynucleotides can also prime the synthesis of RNA. (C.H.)

**28670** (ACRH-19(p.71-81)) STRUCTURE-ACTIVITY CORRELATIONS OF ACTINOMYCINS AND THEIR DERIVATIVES. E. Reich, I. H. Goldberg and M. Rabinowitz (Argonne Cancer Research Hospital, Chicago).

The correlations of structure and antibiotic and cytotoxic activities of actinomycins and their derivatives were investigated in HeLa cells in culture, B. subtilis, E. coli, RNA-polymerase, and HeLa RNA-polymerase. A correlation was found between inhibitory effects on growth of cells, action on DNA-dependent enzymic RNA synthesis, and binding of actinomycin to DNA. The structure of some actinomycins are presented and the effects of structure on activities are discussed. (C.H.)

**28671** (ACRH-19(p.83-95)) BASIS OF ACTINOMYCIN ACTION. I. H. Goldberg, M. Rabinowitz, and E. Reich (Argonne Cancer Research Hospital, Chicago).

Results are reported from studies on the basis for the antibiotic and cytotoxic action of actinomycin. RNA-polymerase, acid-soluble polyribonucleotides labeled with $C^{14}$ or $P^{32}$, and DNA preparations from several sources were used. A hypothesis concerning the mode of action of actinomycin is presented and discussed. (C.H.)

**28672** (BNL-6348) INHOMOGENEITY OF DOSE DISTRIBUTION IN ANIMALS SUBJECTED TO WHOLE BODY. IRRADIATION WITH 250 Kv X-RAYS. Stanley J. Malsky, Charles G. Amato, Victor P. Bond, James S. Robertson, and Bernard Roswit (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 31p.

Even though bi-lateral or more complicated exposure procedures are of considerable importance in total-body exposure of large animals or man, these measures may not result in even approximately the same dose to different tissues. Because of body contour, depth-dose x ray patterns determined in a rice-and-wax phantom contoured to the shape of a dog were appreciably different from the calculated values based on published standard depth-dose tables. In addition to differences due to contour, the tissue traversed by the beam makes considerable difference. Depth-dose patterns in a cadaver dog, compared with the contoured rice-phantom, differed by as much as ±30%. (auth)

**28673** (CEA-2297) RECHERCHE DE CONTAMINATIONS DES VOIES RESPIRATOIRES PAR L'AUTORADIOGRAPHIE DES CRACHATS. (Detection of Contamination of the Respiratory Tracts by Autoradiography of Sputum). Monique Andre and Gilbert Hugot (France. Commissarait à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1963. 8p.

A procedure is described for the detection of $\alpha$-emitting contaminants of the respiratory tract. The method is useful when contamination from inhaled $Pu^{239}$ is suspected. Sputum, collected early in the morning, is dissolved in mineral acids and then evaporated on a stainless steel plate. Radioautograms are prepared by placing the plate in contact with a nuclear emulsion. The number of tracks appearing after 24 and 48 hrs and 7 days is counted. The results are useful in estimating internal contamination and in following removal from the respiratory tract. (C.H.)

**28674** (NP-12940) ANNUAL REPORT NO. 11 [ON GENETICS], 1960. (National Inst. of Genetics, Mishima, Japan). 118p.

Results are summarized from a variety of genetic studies in plants and animals. Emphasis was placed on studies of genetic variations in natural populations of Drosophila melanogaster and mice; differences in DNA content and invasive ability of diploid and tetraploid tumor cells, using Yoshida rat sarcoma and Ehrlich ascites mouse carcinoma as test cells; spontaneous and radioinduced mouse leukemia; the effects of treatment with methylcholanthrene, an extract of Gentiana scabra, $NaN_3$, or chronic $\gamma$ radiation on the growth of tumors in rats; genetic factors affecting enzyme activity in various strains of silkworms, Drosophila, and mice; genetic studies in wild and cultivated varieties of rice, wheat, sugar beets, citrus varieties, tobacco, and other plants; and factors affecting the radiosensitivity of Triturus pyrrhogaster. A list is included of publications during the period covered by this report. (C.H.)

**28675** (NP-12941) ANNUAL REPORT NO. 12 [ON GENETICS], 1961. (National Inst. of Genetics, Mishima, Japan). 135p.

Results are summarized from a variety of genetic studies in plants and animals. Data are included on genetic aspects of the cytology and biochemistry of animals, plants, and microorganisms; radiation genetics in plants and animals; and human genetics. A list is included of publications during the period covered by this report. (C.H.)

**28676** (NYO-10050) BIOLOGY AND MEDICINE. Annual Report on Research Project. (Columbia Univ., New

York. Radiological Research Lab.). Jan. 1, 1962. Contracts AT-30-1-GEN-70 and AT(30-1)-2740. 171p.

The energy expended per ion pair produced in tissue equivalent gases was determined. Experimentally determined rad/r curves about a simulated bone-muscle interface and a muscle-glass interface are given for several x ray beams below 230 kv. Mouse phantom measurements were extended to cover the neutron energy range from 760 to 100 kev. A new tissue equivalent ionization chamber for the measurement of radiation in outer space was designed and constructed. The measurement of dose in terms of the parameter Y was measured for monoenergetic neutrons of five new energies down to 0.1 Mev for tissue sphere sizes ranging from 0.4 u to 12 u. The distribution of dose in terms of a new parameter, Z, the local energy density, was measured with a tissue equivalent proportional counter and specially designed electronic equipment for various absorbed doses and tissue sizes for three types of radiation. A correlation of these results with the RBE's of the different radiation is to be attempted. The construction and initial testing of two ionization chambers for the measurement of RBE dose in mixed radiation fields was completed. A survey of the background radiation in the vicinity of the 400 Mev Synchrocyclotron at Nevis Research Laboratories was undertaken for the purpose of evaluating health hazard to personnel. Tissue equivalent ionization chambers and proportional counters were used to determine the effective RBE dose rate at various locations. An electronic potential generator for ionization chamber current compensation was constructed and tested. Further determinations of RBE as related to neutron energy were carried out with mouse spermatogonia as test objects. Investigations involving other end points are reported in progress. Quantitative cell culture was used in studies of RBE and cell model evaluation. Sources of error in current methods are discussed, and technical improvements are proposed to correct these errors. Experiments performed with a tryptophane-requiring auxotrophic mutant of E. coli strain B/r suggest that there is a saturation effect for uv-induction of reversions to non-requirement. This result in addition to certain properties observed for the reversions may be due to a selective action of uv on cells present in the population before irradiation. This possibility is undergoing further investigations. The relationship between spontaneous sex-linked recessive lethal mutation rate and the rate of aging in D. melanogaster was investigated. Results tend to substantiate some tenets of the somatic mutation theory of aging. (C.H.)

**28677** (TID-17148) EFFECT OF SODIUM CYANIDE ON THE SURVIVAL OF IRRADIATED RATS AND MICE. Jack Schubert and Joan Fried Markley (Argonne National Lab., Ill.). Aug. 1962. Contract W-31-109-eng-38. 7p. (UAC-6733)

Survival in rats and mice given a wide range of doses of sodium cyanide prior to x irradiation was compared. All treatment injections were given intraperitoneally 3 to 6 min before irradiation. Toxicity data for NaCN were also obtained. Total whole-body doses delivered were 850 and 800 r for rats and 750 and 650 for mice. Significant protection was obtained in both rats and mice. In the case of mice given 750 r, the degree of protection increased with increasing dose of cyanide, beginning at a level of about 2 mg/kg. However, in the rat given 850 r, cyanide exerted no appreciable protection until a dose of about 3 mg/kg was reached where a sharp rise in protection ensued. (P.C.H.)

**28678** (TID-18936) THE APPLICATION OF NUCLEAR ENERGY TO AGRICULTURE. Annual Report. Carl C. Moh (Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica). July 1, 1963. Contract AT(30-1)-2043. 62p.

Progress is reported in basic and applied agricultural research using nuclear energy as a tool. Emphasis was placed on tropical agriculture and student training. Results are reported on studies of mutations induced by irradiation of seeds or plant parts of plant species for food crops or local industrial uses. Seeds of 7 pine species that grow at altitudes of 1600 to over 3000 meters, papaya, beans, cassava branches with nodes, and young mahogany plants were irradiated and progenies were examined for mutation frequency and morphology, disease resistance, sensitivity to low temperatures, and other characteristics. Tracer studies of plant physiology included sulfur metabolism in photosynthetic bacteria and plants, iron metabolism in plants, and the effects of iron on growth of coffee and cacao seedlings. Results are included from tracer studies on dispersion and longevity of the Mediterranean fruit fly under natural conditions and the effects of radiosterilization at various developmental stages on eradication of these flies. A list of publications during the period covered by this report is included. (C.H.)

**28679** (TID-18949) BIOLOGICAL AND PSYCHOLOGICAL EFFECTS OF RADIATION IN THE PLANARIAN. Technical Report No. 1. (Michigan. Univ., Ann Arbor). [nd]. Contract AT(11-1)-825. 22p.

The effects of x radiation on the retention of a conditioned response in the planarian, Dugesia tigrina, were studied. Problems of irradiation and dosimetry of roundworms are discussed. (C.H.)

**28680** (TID-18954) COMPLETE SCIENTIFIC REPORT [ON BIOLOGICALLY ESTIMATING EXPOSURE OF ANIMALS TO WHOLE BODY IONIZING IRRADIATION]. (Baylor Univ., Waco, Tex.). Contract [AT(40-1)-2913]. 9p.

Immunological techniques were used in an attempt to determine radiation exposure of rats in terms of relative biological effect and in an attempt to establish a relatively simple laboratory test to determine exposure dosage. The Boyden tannic acid-treated sheep erythrocyte hemagglutination test was used, employing rabbit anti-rat organ serum and the serum from irradiated rats as antigen. Preliminary results showed the onset of the autoimmune-type reaction between 9 and 14 days, with a peak reached at 20 to 30 days. The magnitude of the autoimmune reaction was apparently greater in the lower radiation dose groups, 300 and 500 r. Few of the animals which survived 875 r developed an appreciable titer during the observation period. (C.H.)

**28681** (TID-18980) THE EFFECT OF X-RAY IRRADIATION ON THE LIPIDS OF THE SKIN. Progress Report, October 1, 1962–June 30, 1963. Henry P. Schwarz (Philadelphia General Hospital). Contract AT(30-1)-1864. 17p.

Data are presented from studies on the effects of whole-body x irradiation on the phospholipid content of liver mitochondria in rats. Results of preliminary studies on the in vivo incorporation of $P^{32}$ into mitochondrial phospholipids showed that the irradiation increased $P^{32}$ incorporation proportional with the increase in lipid P. A mitochondrial lipoprotein fraction containing over 80% of nitrogen-free polyglycerol phosphatides was isolated. The relation of mitochondrial lipids to associated enzymes of the electron transfer system is discussed. (C.H.)

**28682** (TID-18992) QUANTITATIVE POPULATION GENETICS OF MICE UNDER IRRADIATION. Progress

Report, July 1, 1962–June 30, 1963. Earl L. Green, Thomas H. Roderick, and Gunther Schlager (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). June 24, 1963. Contract AT(30-1)-1979. 14p.

Populations of mice were propagated by selected inbreeding after gonadal irradiation with doses of 0, 50, and 100 r for several generations. Data from populations representing all combinations of radiation exposure and inbreeding were analyzed for radiation effects on longevity and reproductive performance. A study was also made of the genetic basis for differences in radiosensitivity of mice of different strains. Preliminary data are included from a study of genetic extinction due to gonadal irradiation and the genetic factors involved in resistance to chronic whole-body irradiation in mice. (C.H.)

**28683** (TID-19003) GENETIC AND DIRECT EFFECTS OF $\gamma$ RADIATION ON DROSOPHILA. [Progress Report, 1962]. (Amherst Coll., Mass.). Contract AT(30-1)-2467. 10p.

Progress is reported in studies of the mutagenic effects of different dosage levels of $\gamma$ rays during various stages of spermatogenesis in Drosophila melanogaster under controlled, varied genetic and environmental conditions. Data are presented on the dosage-mutation rate pattern during spermatogenesis, the relation between developmental temperature and mutational response to $\gamma$ irradiation, and the organization of genetic material on chromosomes. An analysis was made of a natural population of D. melanogaster. A list is included of publications during the period. (C.H.)

**28684** (UCRL-10267) NEUTRON DEPTH DOSE FROM $(\alpha,n)$ AND $(\gamma,n)$ SOURCES IN A TISSUE-EQUIVALENT PHANTOM. Henry Aceto, Jr. and Bruce W. Churchill (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 4, 1963. Contract W-7405-eng-48. 36p.

Neutron depth-dose behavior in tissue-equivalent phantom exposed to SbBe, PoLi, Po mock fission, and PuBe point sources was examined with respect to existing theoretical and experimental calculations. Dose from exposure to a point source of complex energy spectra can be estimated by applying a $1/r^2$ geometric correction to the incident neutron flux and comparing the result with the known monoenergetic behavior of neutrons equivalent to the average energy of the point source neutrons. (auth)

**28685** (UCRL-10683) BIOLOGY AND MEDICINE SEMIANNUAL REPORT, FALL 1962. John H. Lawrence, ed. (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion). Dec. 1962. Contract W-7405-eng-48. 185p.

Separate abstracts were prepared for 13 sections of this report. Five sections were previously abstracted and appeared in NSA. A list is included of publications during the period covered by this report. (C.H.)

**28686** (UCRL-10683(p.1-14)) PROTON ACTIVATION IN SPACE VEHICLES. Paul W. Todd (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Proton-induced radioactivity in the inner radiation belt was analyzed from available experimental data in the literature prior to 1961 to estimate its relevance to space flight safety and instrumentation. Proton-excitation functions of carbon, nitrogen, oxygen, and aluminum are presented and used to calculate induced radioactivity in a scintillation detector, an aluminum shell, and in the standard man. Planetary exploration apparatus is also considered. In these cases, induced radioactivity in the inner radiation belt has been found measurable but small. It presents little problem to space flight and exploration but can give rise to a small increase in count rate if low-background counting is performed by specialized detecting devices. In particular, proton-induced radioactivity was found to influence a detection system designed for the determination of the potassium-40 content of the lunar surface. (75 references) (auth)

**28687** (UCRL-10683(p.19-31)) NORMAL IRON ABSORPTION IN MAN. Hiroshi Saito, Thornton Sargent, Howard G. Parker, and John H. Lawrence (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Oral iron absorption was studied in normal male human volunteers using $Fe^{59}$ and a whole-body counter. An intravenous dose served as the equivalent of 100% oral absorption, and also served as correction for geometry in each subject. Data on absorption and excretion are presented. Correlations between reticulocyte count, plasma iron turnover rate, and percent absorption were found, relationships which yield a range of normal values of absorption within narrower limits than absorption alone. After intravenous injection of radioiron, a decrease of whole-body count to 90%, followed by an increase up to 96.5%, was observed; the decrease was greatest at 24 hr after injection when almost all of the radioiron was in the bone marrow. The decrease of whole-body activity is due to the disappearance of radioiron from the serum into the marrow, and the subsequent increase of whole-body activity is due to the appearance of labeled red cells in peripheral blood circulation. No significant difference in percent utilization was noted between iron entering the circulating blood by injection or by absorption from the intestine. Therefore, if the hematopoietic condition of a patient does not change during the period of study, percent absorption can be calculated by the activity appearing in the red cells ten to fourteen days after oral administration and ten to fourteen days after intravenous injection. Because of its simplicity this method should be useful clinically. (auth)

**28688** (UCRL-10683(p.32-7)) WHOLE-BODY IRON LOSS IN MAN. Hiroshi Saito, Thornton Sargent, III, et al. (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Whole-body iron loss was measured with a low-background whole-body counter using as subjects eight normal human males. Total-body iron loss amounted to 1.5 mg per day, or 0.05%, if total-body radioiron loss rate represents total-body iron loss. The radioiron loss curve after the death of a labeled red cell generation was found on the average to be nearly parallel to the initial loss curve. Reutilization of radioiron occurs after the death of labeled red cells, and this leads to change of distribution of radioiron in the body. Thus it is suggested that a decrease of whole-body count after 100 days can be better explained by changes of geometry and greater absorption of gamma rays, due to the change of radioiron distribution in the body, than by a small amount of radioiron loss. (auth)

**28689** (UCRL-10683(p.44-53)) PRELIMINARY RESULTS FROM THE USE OF ERYTHROPOIETIN IN HUMAN VOLUNTEERS. Donald Van Dyke, John H. Lawrence, et al. (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

An attempt was made to determine the minimum effective dose of erythropoietin in man from study of two erythropoietically normal human volunteers. One received an intravenous infusion of erythropoietically active urine from an anemic, thrombocytopenic donor. The other was given an extract of urine from the same donor. The results

indicate that the minimum dose necessary to produce reticulocytosis in a normal human being is approximately 2 C.S. units/kg/day for a period of several days. The dose necessary to produce an unquestionable increase in total circulating red-cell volume is estimated to be approximately 5 C.S. units/kg/day for 7 to 14 days. Higher than normal platelet counts were associated with treatment in both subjects studied, suggesting that the donor excretes in his urine both erythropoietin and thrombopoietin. (auth)

**28690** (UCRL-10683(p.59-74)) CORRELATION BETWEEN ERYTHROPOIETIN TITER, EVIDENCE OF TISSUE HYPOXIA AND HEMOGLOBIN SYNTHESIS IN A NORMAL HUMAN VOLUNTEER ACUTELY EXPOSED TO HYPOXIA. William Siri, Donald Van Dyke, et al. (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A normal subject, acutely exposed to a simulated altitude of 16,400 ft, showed evidence of significant acclimatization within a period of 4 days. Signs and symptoms of hypoxia, severe at first, had largely disappeared by the 4th day. Serial electrocardiograms showed evidence of myocardial hypoxia which was most marked at the beginning of the 3rd day. By the end of the 4th day the electrocardiography had returned to normal. The erythropoietin titer of the serum paralleled the electrocardiographic changes, the highest titer occurring at the beginning of the 3rd day. These findings suggest that the abrupt rise and fall in erythropoietin titer characteristic of acute exposure to hypoxia are the result of initial tissue hypoxia followed by rapid improvement in tissue oxygenation resulting from the initial acclimatization process. Increase and subsequent decrease of hemoglobin synthesis occurred after the corresponding changes in erythropoietin titers; the onset of increased hemoglobin synthesis occurred after 8 hr with maximal hemoglobin synthesis taking place during this experiment approximately 48 hr after the peak erythropoietin titer. (auth)

**28691** (UCRL-10683(p.75-90)) GRADIENT-ELUTION CHROMATOGRAPHY OF RAT-BRAIN-LIPID EXTRACTS. Gary J. Nelson (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Methanol-chloroform extracts of whole rat brain were chromatographed on silicic-acid columns using a concave-gradient-elution procedure. The chromatographic fractions thus obtained were analyzed by various chemical methods, thin-layer chromatography, and infrared spectrophotometry. Cerebroside, serine and ethanolamine phosphatides, sulphatide, lysophosphatidyl ethanolamine, lecithin, and sphingomyelin were eluted as separate fractions. The fatty-acid and fatty-aldehyde composition of the chromatographic fractions and whole brain was determined. Hydroxy acids were found only in the hexose sphingolipids. The highest percentage of unsaturated fatty acids was found in the amino-glycerol phospholipids. Only small amounts of linoleic acid were detected in whole brain or any fraction. (42 references) (auth)

**28692** (UCRL-10683(p.91-7)) SIMULTANEOUS DETERMINATION OF CHOLESTERYL ESTERS AND TRIGLYCERIDES IN SERUM LIPIDS BY INFRARED SPECTROPHOTOMETRY. Norman K. Freeman (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

With the use of a high-resolution grating infrared spectrophotometer, it is possible to analyze mixtures of cholesteryl esters and triglycerides on the basis of the difference in their ester carbonyl absorption frequencies. In the analysis of serum lipids, the preliminary removal of phospholipids is accomplished by a simple batch adsorption on silicic acid. Estimated errors are less than 5%. (auth)

**28693** (UCRL-10683(p.98-106)) ANALYSIS OF LOW-DENSITY LIPOPROTEINS BY PREPARATIVE ULTRACENTRIFUGATION AND REFRACTOMETRY. Frank T. Lindgren, Alexander V. Nichols, et al. (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A simplified method for the analysis of both the glyceride-rich $S_f 20\text{-}10^5$ and the cholesterol-rich $S_f 0\text{-}20$ low-density lipoproteins is presented. It consists of serum-lipoprotein fractionation by preparative ultracentrifugation and subsequent quantitative analysis by refractometry. Comparison of this technique with the technically more difficult analytic-ultracentrifugal methodology reveals comparable results for these two principal low-density-lipoprotein groups. One of the advantages of this procedure is that it provides a reliable and reproducible means for quantitating the principal glyceride-bearing-lipoprotein group, the $S_f 20\text{-}10^5$ lipoproteins. (auth)

**28694** (UCRL-10683(p.110-13)) A QUANTITATIVE DETERMINATION OF THE OSMIUM-TETROXIDE-LIPOPROTEIN INTERACTION. Thomas L. Hayes, Frank T. Lindgren, et al. (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

A quantitative measurement of the uptake of osmium by lipoprotein has been made using an x-ray fluorescence technique to analyze for osmium. Results show osmium tetroxide reacts primarily with double bonds of unsaturated lipids. Applications in the preparation of biological materials for electron microscopy are discussed. (C.H.)

**28695** (UCRL-10683(p.114-30)) INFLUENCE OF THE THYMUS ON THE OUTPUT OF THORACIC-DUCT LYMPHOCYTES. John C. Schooley and Lola S. Kelly (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Thymectomy of rats at 6 to 8 or 30 days of age results in a decreased output of lymphocytes from the thoracic duct. This decreased output is not simply the result of the removal of a lymphoid tissue which discharges lymphocytes directly into the thoracic duct. We suggest that lymphocytes produced in the thymus enter a recirculating-lymphocyte pool, and that removal of the thymus decreases this pool. The decrease in the recirculating-lymphocyte pool is then reflected in a decreased output of lymphocytes from the thoracic duct. Thymectomy of 6 to 8-day-old rats results in a decrease in the weights of the lymph nodes; whereas, no significant difference in these weights is found in rats thymectomized at 30 days of age. The proliferative activity of this decreased amount of lymphoid tissue is similar to that found in an equivalent amount of lymphoid tissue from sham-operated animals. Thus, a greater reduction in the total lymphocyte pool and in the output of lymphocytes from the thoracic duct occurs following neonatal thymectomy than occurs following thymectomy at 30 days of age. The observation that injection of saline extracts of thymus or lymph nodes increases the lymph-node weights of neonatally thymectomized rats implicates a humoral agent in lymph-node development, but certainly does not exclude a cellular contribution by the neonatal thymus. A defective production of bacterial agglutinins could not be demonstrated in rats thymectomized at 6 to 8 days of age, in spite of the reduction in the mass of lymphoid tissue. (auth)

**28696** (UCRL-10683(p.131-51)) THYROID FUNCTION IN CHICKEN AND RAT. I. THE EFFECT OF IODINE CONTENT OF THE DIET AND OF HYPOPHYSECTOMY ON IODINE METABOLISM IN WHITE LEGHORN COCKERELS. Lawson L. Rosenberg, Mildred K. Dimick, and Gilles La Roche (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Various indices of thyroid function were studied in normal and hypophysectomized, 3-month-old white Leghorn cockerels maintained on a low-iodine stock diet and on the stock diet supplemented with iodide. The indices studied were $I^{131}$ uptake, T/S ratio, $I^{127}$ content of the thyroid, and serum-$I^{127}$ levels, both protein-bound and total iodine. The distribution of iodine (both $I^{127}$ and $I^{131}$) in the various iodinated components of the thyroidal iodoprotein was determined after fractionation by paper chromatography, and the effect of iodine content of the diet and of hypophysectomy investigated. Some experiments were performed in rats as a basis of comparison. The studies revealed a low level of circulating thyroid hormone in the serum of intact chickens on the stock diet and a hyperactivity of the thyroid gland; supplementation of the diet with iodide strikingly reduced this activity. Thyroid activity of rats maintained on this low-iodine diet was comparably high as was that in the chickens. When the cockerels were hypophysectomized, although the target organs atrophied and the thyroid activity decreased, as measured by the stated indices of function, an unusually high residuum of activity remained in the thyroid glands. Nevertheless, following the injection of $I^{131}$ the defect, characteristic of hypophysectomized rats and mice, was observed in the labelling of thyroidal thyroxine. Similarly, the thyroids of hypophysectomized rats maintained on low-iodine diet retained high activity if they were from mothers also maintained with inadequate iodine. It is postulated that the unusually high residual activity persisting after hypophysectomy in the thyroid tissue of the chickens and rats on low-iodide diet is attributable to an intense thyrotrophin stimulation caused by dietary iodine insufficiency prior to the removal of the pituitary. (auth)

**28697** (UCRL-10683(p.152-61)) THYROID FUNCTION IN CHICKEN AND RAT. II. THE EQUILIBRATION OF INJECTED IODIDE WITH EXISTING THYROIDAL IODINE IN CHICKEN. Lawson L. Rosenberg, Gilles La Roche and Mildred K. Dimick (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Various indices of thyroid function were studied in normal and hypophysectomized chickens, using $I^{127}$ and $I^{131}$ as tracers. The kinetics of equilibration of iodine newly taken into the thyroid ($I^{131}$) with iodine already present ($I^{127}$) was measured in intact cockerels on stock diet. The time course of labeling was consistent with the concept that iodination and deiodination reactions occur continually in the thyroid gland of intact animals and lead to complete randomization of all thyroidal iodine. (C.H.)

**28698** (UCRL-10683(p.176-9)) AUTORADIOGRAPHIC EVIDENCE FOR A PLURIPOTENTIAL STEM CELL IN THE BONE MARROW. John C. Schooley and Karl Giger (California. Univ., Berkeley. Donner Lab. and California. Univ., Berkeley. Donner Pavilion).

Radioautography was used to trace the development of individual stem cells in the bone marrow of mice injected with $H^3$-thymidine. Results suggest that there is considerable proliferation in the stem-cell compartment of hypertransfused mice, and that upon appropriate stimulation these stem cells can differentiate into either granulocytic, megakaryocytic, or erythrocytic cells. This stem cell is most likely the small round cell of the bone marrow. (auth)

**28699** (USNRDL-TR-641) INHIBITION OF URETHAN LUNG TUMOR INDUCTION IN MICE BY TOTAL-BODY X IRRADIATION. W. A. Foley and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Apr. 24, 1963. 24p.

Groups of young adult (C57L × A)$F_1$ mice received a single intraperitoneal injection of urethan prior to or after a single whole-body lethal dose of x rays (880 rad) followed by transfusion of normal syngeneic bone marrow to protect against radiation death. This dose of urethan produced multiple tumors in 100% of nonirradiated animals at 24 weeks postinjection. In the irradiated animals there was marked suppression of lung tumor formation, both in number of animals with tumors, and in numbers of tumors per tumor-bearing animal. This suppression was present whether urethan treatment preceded or followed radiation. The results imply that urethan lung carcinogenesis may be interfered with by a direct inhibitory effect of the radiation on cells already altered by urethan, or through latent radiation inhibition of pulmonary alveolar proliferative capacity. (auth)

**28700** (USNRDL-TR-644) REDUCED INCIDENCE OF PERSISTENT CHROMOSOME ABERRATIONS IN MICE IRRADIATED AT LOW DOSE-RATE. P. C. Nowell and L. J. Cole (Naval Radiological Defense Lab., San Francisco). May 6, 1963. 18p.

A marked difference in the production of persistent chromosome aberrations in mouse marrow cells by ionizing radiation delivered at a high dose rate (30 rad/min) versus a low dose rate (1.45 rad/hour) was observed. Clones of cell with chromosome abnormalities were present in the marrow of all the mice previously exposed to the x rays, either a single dose or fractionated, at 30 rad/min. The frequency of chromosome aberrations in these mice varied from 14 to 72% of the cells examined. By contrast, none of the 17 mice exposed to the continuous low dose gamma radiation (1.45 rad/hour) showed definite clones of abnormal marrow cells, and the frequency of persistent chromosome aberrations varied from zero to 8% in this group. The possible basis for this marked reduction in the production of persistent chromosome changes in marrow cells following exposure to low dose-rate gamma radiation is briefly discussed. If some of the late effects of radiation, particularly leukemia incidence, are related to the frequency of chromosome aberrations, it is possible that low dose-rate gamma radiation may be less leukemogenic than high dose-rate radiation. (auth)

**28701** (JPRS-19995(p.1-9)) THE PROBLEM OF LIVER PATHOCHEMISTRY AFTER INJURY WITH PLUTONIUM-239. N. I. Elkina (Yelkina) and Z. B. Tokarskaya. Translated from Vopr. Med. Khim., 9: 154-60(1963). (OTS-63-31185(p.1-9))

After the intravenous injection of plutonium nitrate into rabbits in a dose of seven microcuries per kilogram and dogs in a dose of two microcuries per kilogram, a gradually increasing reduction of total protein was found in the sera of the rabbits and dogs caused chiefly by a reduction in the albumin. In the serum of dogs a gradual increase in the activity of transaminases was observed, of glutamic-alanine transaminase to a greater extent and of glutamic-aspartic transaminase, to a lesser degree. A distinct reduction was found in urea synthesis in dogs during the period of development of overt cirrhosis of the liver. The serum alkaline phosphatase activity was increased only in the presence of overt cirrhosis of the liver

and with jaundice. Reduction in the albumin and increase in the transaminase activity preceded the morphologic derangements. (auth)

**28702** (JPRS-20037) CHANGES IN THE ANTERIOR LOBE OF THE HYPOPHYSIS DURING IRRADIATION AND COOLING. E. (Ye.) B. Pavlova. Translated from Probl. Endokrinol. i Gormonoterap., 9: No. 3, 3-7(1963). 8p. (OTS-63-31211)

Comparison of results obtained from studies of morphology and weight changes of suprarenal and thymus glands in rats exposed to lethal doses of x radiation or zero temperature for 4 hrs daily for 1, 3, 5, 10, or 15 days led to the conclusion that changes in the adrenal hypophysis that occur in the early periods after irradiation are similar to those occurring after cooling and reflect increased secretion of ACTH in response to unfavorable factors. (C.H.)

**28703** GASTROINTESTINAL COMPLICATIONS ASSOCIATED WITH RADIATION THERAPY—CHARACTERISTIC, CONFUSING, OR COMPOUNDED. Frank A. Brown (Radiation Therapy Center, Sacramento, Calif.). Am. J. Digest. Diseases, 7: 1006-25(Nov. 1962).

Symptoms resulting from radiation injury of the gastrointestinal tract are discussed and diagnostic techniques are outlined by reference to 13 cases. Gastrointestinal complications attributed to radiation most frequently follow intracavitary radium therapy in the treatment of cancer of the uterus. However, use of external radiation in treatment of certain types of urogenital carcinoma may also be associated with gastrointestinal complaints. As sources of radiation operating at supervoltage levels become more available, the ability to deliver higher depth doses may increase this problem. Small intestine is more susceptible to radiation injury than is the colon, but is less frequently the site of complications. The rectum and adjacent sigmoid colon more commonly are subject to radiation reactions because of their normal anatomic fixation and proximity to radium applicators used in the treatment of uterine cancer. The acute radiation gastrointestinal syndrome, occurring during or immediately after a course of radiation therapy, is described. Chronic or delayed symptoms are identified. Physical and endoscopic findings of ulceration, stricture, and induration frequently suggest recurrence of pelvic cancer, the incidence of which is markedly increased by previous surgical or inflammatory changes in the pelvis. (H.H.D.)

**28704** PLATELETS AND PHARMACOLOGIC COMPOUNDS IN RADIATION-INDUCED HEMORRHAGIC DIATHESIS. Giovanni Raccuglia and Chris J. D. Zarafonetis (Simpson Memorial Inst., Ann Arbor, Mich.). Am. J. Med. Sci., 244: 152-69(Aug. 1962).

Studies were undertaken to standardize a technique for quantitative measurement of the bleeding tendency associated with thrombocytopenia in irradiated animals and to evaluate the hemostatic activity of a number of compounds in thrombocytopenic animals using this technic. Thrombocytopenia was induced by exposure of rats to $Co^{60}$ γ radiation. Bleeding time (BT), measured by the wound blotting method was found suitable for the evaluation of the hemorrhagic tendency. BT and platelet counts were altered the first day after exposure to 1300 rep; at the third day for 850 rep; at the sixth for 600 and 500 rep. BT, progressively longer after exposure to radiation, reached maximum length somewhat before the lowest point of the average curve of platelet counts. The linear relation between platelet counts and bleeding times observed in normal rats was also present in the animals rendered thrombocytopenic by irradiation. Study of blood vessels in vivo demonstrated in the rats irradiated with 850 rep, in comparison with the normal animals, marked vascular congestion. Other abnormalities of blood vessels are identified. The m.a. values of thrombelastography decreased in a parallel fashion with the average curve of the platelet count in all groups of animals. The values observed for recalcification time tests were erratic, but prothrombin times remained unchanged. Hematocrit values decreased progressively and more severely in the rats exposed to higher radiation doses. Serum protein electrophoretic patterns did not demonstrate any characteristic changes. Mortality was 100% in 4 days and 11 days respectively in the 1300 and 900 rep groups. Human platelets infused into the irradiated rats did not correct the bleeding tendency, but when injected into non-irradiated rats was followed by a decrease of the platelet count of the recipients. Nonstored rat platelets were able to correct the bleeding time of irradiated thrombocytopenic rats, and the quantitative aspects of this therapy were studied, stored platelets did not correct the bleeding tendency of irradiated thrombocytopenic rats. Hydrocortisone succinate, adrenochrome monosemicarbazone-salicylate complex, conjugated estrogen, and citrus bioflavonoids with ascorbic acid were ineffective in modifying the BT of the irradiated thrombocytopenic rat. Treatment with hydrocortisone in the postirradiation period did not protect from the development of thrombocytopenia. (H.H.D.)

**28705** THE EFFECT OF X-RAY IRRADIATION ON THE PHOSPHOLIPIDS OF THE LIVER MITOCHONDRIA. H. P. Schwarz, L. Dreisbach, and A. Kleschick (Philadelphia General Hospital). Arch. Biochem. Biophys., 101: 103-7(Apr. 1963).

Evidence is presented that whole-body x irradiation produces increase of total lipid phosphorus as well as change of phospholipid distribution in liver mitochondria of fasted rats. One polyglycerolphosphatide, which was identified as phosphatidylglycerol, increased out of proportion to over four times of the control value to become a significant component of the irradiated mitochondria. The other polyglycerolphosphatide, cardiolipin, conversely was possibly even lower after the x rays. The phosphorus value of phosphatidylethanolamine dropped even more significantly almost balancing the relative increase of phosphatidylglycerol. Phosphatidylcholine, phosphatidylserine, phosphoinositide, and sphingomyelin per cent values were slightly lowered or unchanged by the irradiation. The changes also affected the actual amounts of the individual mitochondrial phosphatides per gram wet liver in a different manner. The actual amount of mitochondrial phosphatidylglycerol thus increased over four times, that of phosphatidylcholine only by 21%, while the amounts of the other phosphatides remained almost unchanged after the x rays. (auth)

**28706** THE AGE DEPENDENCY OF ALDOLASE AND MALIC DEHYDROGENASE ACTIVITY IN GUINEA PIG LENS. THE INFLUENCE OF X RADIATION ON THE ACTIVITY OF BOTH ENZYMES. W. Paulus and O. Hockwin (Universitäts-Augenklinik, Bonn). Arch. Ophthalmol., 163: 314-19(1961).

Activities of the enzymes were determined by spectrophotometric methods in homogenates of the lenses of embryonic, young, middle-aged, and old guinea pigs. The lenses of these four groups of animals weighed 15–32, 43, 95, and 110 mg. Aldolase activity increased with the increase in lens wt to a maximum value corresponding to 50 mg lens wt, then sharply declined with a further increase in lens wt. Irradiation of the lens in vitro with 100 kr diminished aldolase activity ~15% in embryonic

lens, 30% in young lens, and 10% in old lens. In unirradiated lens this activity was 17% lower in embryonic and 50% lower in old lens, than in young lens, which showed maximum activity. This result suggests that radiation has similar effects in lenses of different age. The age-dependent activity curve of malic dehydrogenase (MDH) has a different shape from that of aldolase, in that MDH activity declines steadily with age to a lens wt of 40 mg, then levels off and does not change subsequently with age. Thus, MDH activity is ~40% higher in embryonic than young or old lens. Irradiation with 100 r produced only a very slight depression in MDH activity, and this depression was the same in lenses of all ages. Hence, the reaction of lens to irradiation does not seem to be influenced by age. (H.H.D.)

**28707** COLPOCYTOLOGIC FINDINGS AFTER INTRAUTERINE RADIUM TREATMENT FOR BENIGN DISORDERS OF THE ENDOMETRIUM. Paolo Romeo (Università, Pisa, Italy). Arch. Ostet. Ginecol., 66: 377-95 (July-Aug. 1961).

Changes in vaginal cytology are described following Ra therapy of metrorrhagia at the climacterium in 17 women. Intrauterine implantation of Ra gave total doses of 4120 to 6000 r. In all cases, independently of their age (41–70 yr), immediately after treatment an increase was noted in pyknotic and acidophilic vaginal cells. This increase was maintained for 20 to 25 days, independently of the age or menstrual status of the patient. Vaginal smears in this period showed a high proportion of superficial cells, mostly in clumps and with clear cytoplasm and precociously pyknotic nucleus, along with abundant mucus and well-preserved leukocytes. The proportion of pyknotic cells reached a maximum of 60–80%, as did the number of acidophilic cells (40–60%), on the 8th to 12th day after treatment. After 20 days the number of superficial epithelial cells declined as the number of deeper cells rose, and after a month, basophilic cells with large nuclei predominated. The increase of acidophilic, pyknotic cells immediately after Ra treatment was accompanied by augmentation of alkaline phosphatase activity in the cytoplasm of vaginal epithelial cells; this activity began to decline 15–20 days after treatment. These changes in vaginal cytology, on account of stimulation of vaginal mucosa, are attributed to increased production of estrogen by the adrenal cortex. The hypercorticodism is probably the result of nonspecific stress caused by radiotherapy. In over half the patients, vaginal smears taken 4 to 8 months post-treatment showed that ovarian activity was still present. It is concluded that intrauterine Ra therapy induces persistent estrogenic stimulation of the vaginal mucosa. (H.H.D.)

**28708** X RAY SENSITIVITY OF CONIDIA OF COLLECTOTRICHUM COCCODES (WALLR.) HUGHES. N. Loprieno and A. Nannarone (Università, Pisa, Italy and C.N.E.N., Rome). Atti Assoc. Genet. Ital., 8: 42-4(1963). (In Italian)

Conidia collected from 6-day-old cultures of Colletotrichum coccodes were washed, resuspended in distilled water, and exposed to various doses of x radiation. Samples of the conidia were then seeded on complete media and survival was evaluated after 3 days by counting the number of colonies. Results demonstrate a very high sensitivity of this fungus to the lethal effects of x rays. (C.H.)

**28709** INDUCTION OF CROSSING-OVER IN DROSOPHILA MELANOGASTER MALES WITH VARIOUS DOSES AND FRACTIONATED DOSES OF X RAYS. A. Olivieri and G. Olivieri (Università, Rome). Atti Assoc. Genet. Ital., 8: 181-93(1963). (In Italian)

Studies on the induction of crossing-over in male Drosophila melanogaster chromosomes following exposure to various dose rates and fractionated doses of x rays showed the existence of a stage of greatest sensitivity during spermatogenesis. A significant decrease of induced crossing-over in the centromeric region was observed after exposure to fractionated doses. The possible relation between radioinduced crossing-over and chromosome breaks is discussed. (C.H.)

**28710** PRELIMINARY RESULTS OF COMBINED EFFECTS OF OXYGEN AND LOW TEMPERATURES ON MUTATIONS INDUCED BY X RAYS IN DROSOPHILA. S. Giavelli, E. Gallucci, L. Pozzi, and G. Sironi (Università, Milan). Atti Assoc. Genet. Ital., 8: 194-204(1963). (In Italian)

In order to study the mechanism of the oxygen effect in x-ray–induced mutations, Drosophila melanogaster Oregon-R males were irradiated in oxygen at 25°C and 0°C., thus at normal and low metabolism. Sex-linked x-ray–induced recessive lethals were scored, and no difference was found in the mutation frequency induced by the two treatments at different temperature. The oxygen effect was considered independent from the metabolism of the irradiated cells. (auth)

**28711** RADIOGENETICAL EXPERIMENTS WITH HIGHER RESOLVING POWER IN MAIZE. A. Bianchi and M. Contin (Università, Milan and Università Cattolica del S. Cuore, Piacenza, Italy). Atti Assoc. Genet. Ital., 8: 257-67(1963). (In English)

Methods, having high resolving power in maize, were evolved for scoring of mutations in experimental populations. These methods promise to be useful for analyses of the nature of artificially induced mutations in this species. Besides the classical procedure which make use of endosperm markers and the use of pollinator stocks possessing translocations between A and B chromosomes, the behavior of wx locus in chromosome 9 is presented. Mutations to Wx, which can readily be made visible in pollen grains of wx plants by iodine staining, are so easily scored that the resolving power with this experimental approach is not different from that usual in microbial genetics. X irradiation of wx plants with 560 to 1680 roengten, distributed in one week at the meiotic stages, while obviously able to increase the percentage of empty pollen grains, was unable to affect the frequency of back-mutations (wx to Wx) on the basis of several million grain elements. Results indicate that the rate of point mutations remains unchanged. (auth)

**28712** EFFECTS IN THE FIRST GENERATION OF IRRADIATION OF GAMETES IN HORDEUM VULGARE. B. Donini (C.N.E.N., Rome). Atti Assoc. Genet. Ital., 8: 268-78(1963). (In Italian)

Possible differences in radiosensitivity of male and female gametes in Hordeum vulgare were investigated after irradiation of plants in a $\gamma$ field two days before the blooming stage. Some plants were isolated soon after irradiation in order to have zygotes from irradiated female and male gametes, unirradiated plants were pollinated with irradiated pollen, and irradiated plants were pollinated with unirradiated pollen. Results of examinations of the $R_1$ generation for seed germination, types and frequency of aberrant seedlings, survival at maturity, and spike fertility indicated a depressing effect on all parameters in the offspring of both irradiated gametes and of irradiated male gametes. No appreciable effect of female gamete irradiation was noted. (C.H.)

**28713** COMPARISON OF THE MUTAGENIC EFFECT OF IONIZING RADIATION AND CHEMICAL AGENTS IN TRITICUM DURUM Desf. G. T. Scarascia Mugnozza, A. Bozzini, F. D'Amato, and L. Monti (C.N.E.N., Rome and Università, Pisa, Italy). Atti Assoc. Genet. Ital., 8: 279-302(1963). (In Italian)

The comparative effects of x rays, thermal neutrons, fast neutrons, diethyl sulfate, and ethyl methane sulphonate were studied, using dry seeds of the cultivated varieties Aziziah, Cappelli, and Russello of durum wheat. Aziziah was found as the most radiation sensitive variety; no statistically significant difference in radiation sensitivity between Cappelli and Russello was ascertained. Excluding the results of two chemical treatments, the three varieties studied did not differ from each other as to frequency and spectrum of chlorophyll mutations in the second generation ($M_2$). At comparable survival rates, mutation and mutant frequencies in $M_2$ were two to several times higher after neutron irradiation than after x rays. In the radiation series, maximum rates of chlorophyll mutations were found in treatments producing a 50 to 80% reduction in the mean number of $M_2$ seedlings per spike; in the most efficient chemical treatments, the reduction in seedling number per spikes was comprised between 33 and 42%. Chemically induced spectra of chlorophyll mutations were quite distinct from those resulting from irradiation; they were characterized by a reduced frequency of albina and a greater frequency of xantha and viridis. If the distribution of albina, xantha, chlorina, and tigrina was considered in relation to seedling number per spike, they showed a clear accumulation in lower spike fertility classes in the radiation series. In the chemical mutagen series, albina, xantha, and chlorina occurred frequently in spike classes with good fertility, while tigrina typically accumulated in spikes with clearly reduced fertility. Evidence was found that, in chemically treated materials, the mean size of mutated sectors in $M_1$ spikes is much smaller than following irradiation. It was estimated that, in several $M_1$ spikes from chemical treatments, four or possibly more initial cells were to be made responsible for the organization of a spike. (auth)

**28714** ANALYSIS OF PHENOTYPIC VARIABILITY IN PROGENY OBTAINED FROM SEEDS TREATED WITH X RAYS AND SEEDS NOT TREATED OF T. DURUM. R. E. Scossiroli and S. Pellegrini-Scossiroli (Università, Pavia, Italy). Atti Assoc. Genet. Ital., 8: 303-13(1963). (In Italian)

An experiment was started in 1959 to induce new variation for quantitative characters by treatment of seeds with x rays. Doses of 10,000 r, 20,000 r, and 0 r (control) were given to seeds of Triticum durum, var. Cappelli. $R_2$ and $R_3$ progeny were obtained by selfing. The highest dose was found to be lethal at the seedling stage. Observations of several morphological and production traits were performed in the $R_2$ and $R_3$ generations obtained in 1961 under the same experimental conditions. A depressing effect of irradiation for almost all traits considered was found for both generations. The difference between means for treated and control groups was found, however, to be smaller in the $R_3$ generation. A hierarchical scheme of analysis of variance was used to study the effect of the treatment on variability. Very little information may be obtained from the $R_2$, while in $R_3$ generation the treated group given significant estimates of genetic variability for almost all the observed characters. Results shows the effectiveness of radiation in inducing through mutation new variation which may be available for plant breeding purposes. (auth)

**28715** EFFECTS OF TREATMENT OF SEEDS WITH X RAYS IN TRITICUM AEST. VULGARE. D. L. Palenzona (Università, Pavia, Italy). Atti Assoc. Genet. Ital., 8: 314-21(1963). (In Italian)

The 2nd and 3rd generation obtained under selfing from irradiated and nonirradiated seeds were studied in the hexaploid wheat (T. ae. vulgare, ev. Damiano). Statistical analysis was performed for 14 quantitative traits using a hierarchical scheme of analysis of variance in order to identify estimates of portions of genetic origin of variance present in the irradiated as well as in the nonirradiated population. Assuming an effect of mutants on variability of quantitative traits, the x-ray–induced mutations should result in an increase of variation, that is, in out analysis, in an increase of the genetic portion of the total phenotypic variance. According to the usual segregation model induced mutations would appear in the phenotype at $R_2$ generation and consequently determine an increase of genetic variance. In hexaploid wheat considered in this study the estimates of genetic variance for quantitative traits increased only at the third generation. This suggest that the ploidy level may have buffered the phenotypic expression of induced mutations. It was concluded that the phenotypic appearance of mutations in polyploids is dependent from accumulation in the genotype of several single mutational events and that different loci are involved in the genetical determination of the quantitative traits studied, according to a multifactorial hypothesis. (auth)

**28716** MODIFICATION OWING TO POST-TREATMENT OF GENETIC DAMAGE IN KERNELS OF IRRADIATED MAIZE. G. Gavazzi (Università, Milan). Atti Assoc. Genet. Ital., 8: 322-33(1963). (In Italian)

The storage effect in maize kernels following x irradiation was studied. The frequency of yellow-green sectors on the green background of maize seedlings heterozygous Yg/yg (Yg = yellow green 2 on the short arm of chromosome 9) has been used as a criterion of measuring the induced genetic damage in seeds possessing water content of 4 (dry seeds) or 11% (normal seeds) maintained during the storage at two different levels of temperature. It has been possible to show that the damage is increasing during the first 2-4 hours of storage, while later on, the behavior is slowly reversed. High temperature during the storage has been found having a protective effect. Such storage effect is less obvious in normal than in dry ones. (auth)

**28717** EFFECTS ON LYMPHOID CELLS OF OCCUPATIONAL EXPOSURE TO LOW DOSES OF IONIZING RADIATION. D. O. Shiels (Univ. of Melbourne). Australasian Ann. M[illegible]., 11: 267-9(Nov. 1962).

It is suggested that blood tests of the type described may be of value in the supervision of persons exposed to ionizing radiation, and further that such may be more valuable than environmental monitoring. Characteristics of lymphocytes relative to effects by ionizing radiation are discussed. (H.M.G.)

**28718** DEOXYRIBONUCLEIC ACID REPLICATION IN BACTERIA FOLLOWING ULTRAVIOLET IRRADIATION. D. E. Pettijohn and P. C. Hanawalt (Stanford Univ., Calif.). Biochim. Biophys. Acta, 72: 127-9(May 28, 1963). (In English)

The thymine-requiring bacterium TAU-bar (Escherichia coli 15T⁻ with additional requirements for uracil, arginine, methionine, proline, and tryptophan) was cultured in a synthetic medium plus required supplements. Exponentially growing cultures at 37° were harvested by rapid filtration and resuspended in 0.1 M Tris buffer (pH 7.4) at room

temperature to a concentration of $6 \cdot 10^8$ cells/ml. Ultraviolet radiation was performed in a dimly illuminated room on 50-ml aliquots of the bacterial suspension in a petri dish (with magnetic stirring) at a distance of 37 in. from a 15-W germicidal lamp (95% output at 254 mμ). The dose used involved 3 min exposure, and reduced viable colony count to about $10^{-2}$%. Following irradiation the bacteria were returned to 37° synthetic growth medium, but with the thymine supplement replaced by 2.5 μg/ml 5-bromo[2-$C^{14}$] uracil at specific activity 8.8 mC/mM. After 110 min of growth following ultraviolet light, the 5-bromouracil incorporation (measured as the radioactivity in a cold trichloroacetic acid-insoluble fraction) indicated that no more than 6% of the DNA could have replicated. A typical density profile of the DNA which was obtained from cells after this procedure is shown. Most of the absorbency of the E. coli DNA remained at the normal position, since little replication occurred. The 5-bromouracil-containing material was at a position intermediate between the normal and hybrid positions. The breadth of the 5-bromouracil-containing band is suggestive of density heterogeneity. The lighter-than-hybrid density is not due to debromination of some of the 5-bromouracil-containing DNA since paper chromatography of an acid hydrolyzed preparation of this material yields only a single $C^{14}$-activity peak with the proper $R_F$ for 5-bromouracil. Unlike the hybrid DNA formed in an unirradiated culture, the intermediate density material does not separate into heavy and light density sub-units on heating to 100° for 15 min in 0.01 M NaCl. This is further evidence for unusual properties in newly synthesized DNA following ultraviolet irradiation. These results are consistent with the hypothesis that some type(s) of photochemical damage to DNA may result in the partial replication of the DNA molecule. (auth)

**28719** GENETIC TRANSFORMATION STUDIES. III. EFFECT OF ULTRAVIOLET LIGHT ON THE MOLECULAR PROPERTIES OF NORMAL AND HALOGENATED DEOXYRIBONUCLEIC ACID. Zofia Opara-Kubinska, Zofia Kurylo-Borowska, and Waclaw Szybalski (Univ. of Wisconsin, Madison). Biochim. Biophys. Acta, 72: 298-309(June 25, 1963). (In English)

The transforming activity of 5-bromodeoxyuridine-labeled DNA is more sensitive to ultraviolet light than that of normal (non-labeled) DNA. The more rapid ultraviolet-irradiation inactivation of 5-bromodeoxyuridine labeled DNA, as compared with nonlabeled, is reflected also by greatly increased affinity of ultraviolet-irradiated 5-bromodeoxyuridine-labeled DNA for the methylated albumin column, decrease in density (dehalogenation) and very pronounced band spreading (degradation, increased heterogeneity), as revealed by CsCl equilibrium-density centrifugation of ultraviolet-irradiated native 5-bromodeoxyuridine-labeled DNA's, and marked cross-linking between complementary strands of 5-bromodeoxyuridine-labeled DNA, as determined with ultraviolet-irradiated and denatured material centrifuged in the $Cs_2SO_4$ density gradient. (auth)

**28720** CARDIAC DAMAGE AFTER RADIOTHERAPY. Raymond Windsor (Green Lane Hospital, Auckland, N. Z.). Brit. Med. J., 1: 382-3(Feb. 9, 1963).

A case is reported of radiation injury of the heart resulting in fatal rupture of the right atrium during surgical incision of the pericardium. A tumor in the right-lower lobe bronchus had been irradiated 2 months earlier. It is estimated that the portion of myocardium in the field would receive between 4000 r posteriorly and 5250 r anteriorly. At postmortem examination the heart was flabby and grossly abnormal. The patient had no signs of myocardial insufficiency, but the state of the heart at operation indicated that the radiation effects were quite severe. It is not suggested that any change in radiotherapy technique is indicated as a result of this fatality, but the possibility of radiation damage to myocardium receiving 4000–6000 r should be considered. (H.H.D.)

**28721** EFFECTS OF X IRRADIATION ON PULMONARY TUMOR FORMATION INDUCED BY URETHAN IN THE MOUSE. J.-F. Duplan (Institut du Radium, Paris). Bull. Assoc. Franc. Etude Cancer, 49: 260-9(July-Sept. 1962).

The effect of thoracic irradiation on the development of pulmonary tumors in XVII/G mice injected intraperitoneally with urethan was investigated. Urethan alone caused an increase in lung wt that corresponded with development of pulmonary tumors. Irradiation alone also caused a rise in lung wt due to the edema and congestion occurring in the inflammatory response. After urethan and x-ray treatment the rise in lung wt was depressed, presumably because of depression of the inflammatory reaction by the antimitotic action of urethan. The urethan-induced tumors in most cases were adenomas, and irradiation did not appear to augment the malignancy of the tumors. The results indicate that radiation renders the lung resistant to the tumorigenic action of urethan. (H.H.D.)

**28722** THE MELANO-SEBACEOUS FORMATION OF THE GOLDEN HAMSTER. II. SHORT-TERM REACTION TO LOCAL IRRADIATION BY MEANS OF X RAYS. B. Oberman and M.-R. Riviere (Institut de Recherches Scientifiques sur le Cancer, Villejuif, France). Bull. Assoc. Franc. Etude Cancer, 49: 320-30(July-Sept. 1962).

A study of radiation effects on the melano-sebaceous formation of the golden hamster (Mesoricetus auratus) was made in an attempt to gather information concerning development of melanotic tumors. (H.M.G.)

**28723** THE PRODUCTION OF CHROMATID ABERRATIONS BY 5-FLUORODEOXYURIDINE (FUDR) ALONE AND IN COMBINATION WITH X RAYS AND 8-ETHOXYCAFFEINE (EOC). B. A. Kihlman (Uppsala Univ., Sweden). Caryologia, 15: 261-77(1962). (In English)

In Vicia faba lateral root-tips cell divisions containing chromosomal aberrations began to appear ~3 hr after immersion of the roots in solutions containing FUDR in concentrations of 0.5 μM or higher. The aberrations consisted mainly of gaps and chromatid breaks. Aberrations involving rejoining (isochromatid breaks with sister union, exchanges) were extremely rare. FUDR also had a strong inhibitory effect on mitosis. Fifteen to 30% of the cells dividing 24-6 hr after a 1-hr treatment with 1 μM FUDR contained chromatid aberrations of the usual type. The effects of FUDR increased with temperature and were stronger at low than at high pH. When x irradiation was combined with FUDR treatment, there was a marked increase in the number of gaps, chromatid breaks, and metaphases with extreme fragmentation in comparison with the x-ray control. When EOC was combined with FUDR, the effect was smaller than the sum of the effect of each alone. FUDR did not affect the frequencies of EOC-induced exchanges and isochromatid breaks with sister union. The effect of FUDR, on the other hand, was markedly reduced by EOC. (TCO)

**28724** CHARACTERISTICS OF CUTANEOUS RADIOVACCINATION. Jean Loiseleur, Liliane Catinot, and Annick de Vomécourt. Compt. Rend., 256: 4768-9(May 27, 1963). (In French)

The radiovaccination effect, obtained by the succession of two irradiations administered with an interval of five days on two different cutaneous fields, is accentuated when the irradiation dose becomes very high. The essential condition resides in the interval of several days that must separate the two irradiations. (tr-auth)

**28725** CHROMOSOMIC ANOMALIES AFTER WHOLE-BODY IRRADIATION IN MAN. Martine Papiernik-Berkkauer, Jean-Louis Amiel, and George Mathé (Hôpital Saint-Louis, Paris). Compt. Rend., 256: 5232-5(June 10, 1963). (In French)

Chromosomic anomalies very probably connected with irradiation were observed in a patient with acute lymphoblastic leukemia, irradiated in toto during a period of apparently complete remission. (tr-auth)

**28726** EFFECT OF AET ON CELLULES OF THE SPERMATOGENIC LINE OF MICE IRRADIATED LOCALLY ON THE TESTICLES. A. Leonard and J. R. Maisin (CEN, Mol, Belg.). Compt. Rend. Soc. Biol., 157: 409-12(1963). (In French)

Male hybrids were divided into three groups: the controls, the group receiving 342 r, and the group receiving 5472 r. Half of each irradiated group had an intraperitoneal injection of AET 10 minutes before irradiation. The testicle lesions were estimated by calculating the percentage of seminal tubes lacking one of the stages of the spermatogenic line: spermatogones, spermatocytes, spermatids, or spermatozoids. The results show that the radiosensitivity decreases with the degree of differentiation. The extent of the lesions caused by x radiation and the time before regeneration can be observed is a function of the dose. Along with the disappearance of the cellules of the spermatogenic line, the testicles decrease in weight. Injection of AET before irradiation has a protective effect, slowing a speeded disappearance of the germinal cellules and accelerated restoration of the seminal epithelium. (J.S.R.)

**28727** CONCENTRATION OF DESOXYRIBOPOLYNUCLEOTIDES IN RADIOSENSITIVE AND RADIORESISTANT TISSUES AFTER IRRADIATION. J. Matyasova, M. Skalka, and J. Soska (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Compt. Rend. Soc. Biol., 157: 451-4 (1963). (In French)

A study was made to determine the relation between the radiosensitivity of a tissue (or the rapidity of its nucleic metabolism) and the liberation of desoxyribopolynucleotides after irradiation. Mice of the H race and Wistar rats were used in the study. They were decapitated four hours after whole-body irradiation with a dose of 600 r. The concentration of the desoxyribopolynucleotides was determined in the spleen, thymus, liver, and kidneys. The results are shown graphically. In order to determine the participation of lymphocytes in the release of desoxyribopolynucleotides, tests were made on mice that received injections of cortisone for seven days before irradiation. The increase in desoxyribopolynucleotides after irradiation in the spleen is much less than in normal mice, whereas in the thymus the increase is insignificant. The increase of the concentration of desoxyribopolynucleotides after irradiation does not occur in all radiosensitive tissues with rapid exchange of DNA. This change occurs only in lymphatic and hematopoietic tissues. (J.S.R.)

**28728** PARTICIPATION OF ADRENAL REACTION IN THE VARIATION OF THE METABOLISM OF DNA AFTER IRRADIATION. M. Skalka and J. Soska (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Compt. Rend. Soc. Biol., 157: 455-8(1963). (In French)

The effect of the adrenals and their hormones on the alteration i the metabolism of DNA after whole-body irradiation was studied in mice. The relative specific activities of the DNA in the spleen and duodenum were determined 2, 4, 12, and 24 hrs after irradiation in mice with the following treatment: irradiated with mock adrenalectomy, irradiated with adrenalectomy, unirradiated and injected with desoxycorticosterone, irradiated, irradiated and injected with desoxycorticosterone, unirradiated with cortisone injection, and irradiated with cortisone injection. The graphed results show that adrenalectomy or the administration of desoxycorticosterone reduces to a certain degree the initial decrease in the synthesis of DNA after irradiation. The administration of cortisone exercises, on the contrary, had a synergetic effect by increasing the postirradiation alterations. Interventions in the equilibrium of corticoadrenal hormones affect the rapidity of the synthesis of DNA in the irradiated organism. (J.S.R.)

**28729** PRODUCTION OF SUBCORTICAL LESIONS BY IMPLANTATION OF RADIOACTIVE SUBSTANCES. J. B. Campbell, H. H. Rossi, Marion H. Biavati, and B. J. Biavati (Columbia Univ., New York). Confina Neurol., 22: 178-82(1962).

Stereotaxic implantation of $Pd^{109}$ and $Y^{90}$ spheres in subcortical structures in the brains of cats showed that these pure sources of $\beta$ radiation can be relied upon to produce histologically standardized lesions. Max lesion volume is dependent upon the energy of the $\beta$ rays emitted, and variation of source strength permits adjustment of the diameter of the resultant radionecrosis. Two weeks after implantation the spheres were surrounded by a zone of cytological change and there was an irregular transition from dead, to damaged, and normal cells. Beyond this was a ring of edema. Although stereotaxic placement of a sphere of this strength in the area produced a lesion, none of the metabolic changes previously caused by electrocoagulation of the area developed, and the animals remained healthy until killed 3 weeks after operation. The difference obtained with the radionecrotic method is accounted for on the basis that the lesions are discrete and gradual in development. Clinical trial of this method was undertaken in which 2 $Y^{90}$ sources, each ~400 mC in strength, were implanted in the globus pallidus of individuals with parkinsonism. The resultant clinical improvement indicated that quantitated radionecrosis might have a place in stereotaxic neurosurgery. A stereotaxic manipulator, constructed for delivery of sources of $\beta$ radiation and so shielded as to hold the radiation exposure of the operating personnel at negligible levels, is described. (H.H.D.)

**28730** A BIOLOGICAL ESTIMATE OF THE ACCUMULATED IRRADIATION DOSE IN WARM-BLOODED ANIMALS BY DETERMINING THE PERCENTAGE OF CELLS IN THE MARROW WITH CHROMOSOMAL ABERRATIONS. N. F. Barakina, I. M. Shapiro, and M. I. Yanushevskaya (Severtsov Inst. of Animal Morphology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 149: 1187-9 (Apr. 11, 1963). (In Russian)

Mice of both sexes with a weight of 18 to 20 grams were given x-ray doses of 200, 400, 700, and 1000 r. The mice were killed ¼, 1, 2, 3, 5, and 8 days after the irradiation. Samples of the thigh marrow were fixed and stained in order to count the chromosomal aberrations which were determined at the late anaphase or early telophase stage. Six hours after the irradiation, the percentage of cells with aberrations was 90%, but no differences in the effect of a dose of 200 r and a dose of 1000 r could be detected. One day after irradiation, the percentage of cells with

aberrations varied linearly with the dose from 200 r to 1000 r. The irradiation dose could be determined with an accuracy of 200 r at the 99% confidence level. If the dosimetry were carried out 48 hours after the irradiation, the resolution of the method was a factor of two less, and the effects of doses differing by 400 r could be distinguished at the 95% confidence level. The method could also be used to determine the total dose to various parts of the body by taking marrow biopses from various sections of the hematopoietic system. (TTT)

**28731** THE EFFECT OF ANTIBIOTICS ON THE RADIATION DAMAGE TO YEAST. Yu. A. Kriger, A. Kh. Tambiev, and Le Suan Tu (Moscow Univ.). Dokl. Akad. Nauk SSSR, 149: 1190-3(Apr. 11, 1963). (In Russian)

Diploid yeast cells of Saccharomyces vini of the Megri 139 B strain were grown at 30°C on a solid wort-agar medium. After 48 hours, 0.1 ml of a $10^{-4}$M solution of antibiotic was added to the yeast culture which was then subjected to a $\gamma$ dose of 80 kr from a $Co^{60}$ source. The irradiations were carried out in air, in vacuum, and in oxygen (300 mm Hg std). The survival of the irradiated cells was used as a measure of the radioprotective effect of the antibiotic. All the antibiotics (gramicidin, penicillin, fumagillin, aureomycin, aurantine, and streptomycin) showed a radioprotective effect on irradiating the yeast cells in air and in oxygen. Fumagillin and gramicidin showed a pronounced radioprotective effect on irradiation in a vacuum, but streptomycin and aurantine showed no protective effect under these conditions. The antibiotic showed no radioprotective effect, when it was added to the yeast cells 5 minutes after the irradiation. It was shown that the bactericidal properties of the antibiotic are not associated with its radioprotective properties by comparing the anti-bacterial activity of an aureomycin preparation with its radioprotective properties on storage of the aureomycin over a period of 50 days. The anti-bacterial activity decreased with time, but the radioprotective properties of the aureomycin remained constant with time. Potentiometric measurements of the redox potential of a suspension of yeast cells before and after addition of the antibiotic to the solution showed that addition of the antibiotic lowers the redox potential of the suspension. The greater the decrease in redox potential, the more effective was the antibiotic. (TTT)

**28732** THE CHANGE IN CARBOHYDRATE COMPOSITION WITHIN THE STORAGE ORGANS OF PLANTS UNDER THE EFFECT OF GAMMA IRRADIATION. E. G. Sal'kova (Bakh Inst. of Biochemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 149: 1203-5(Apr. 11, 1963). (In Russian)

Onion bulbs, garlic bulbs, and apples were subjected to $\gamma$ radiation, and the changes in carbohydrate content were determined at 5 days and 2 months after irradiation. No accumulation of sugars could be detected in the onion or garlic bulbs up to a dose of 60,000 r. The content of monosaccharides decreased from 1.75% of the dry weight for the controls to 1.15% on the 5th day after irradiation of the onion bulbs with a dose of 30,000 r. No break-down of polysaccharides due to irradiation could be observed in the onion or garlic. No change in the monosaccharide content of irradiated onion bulbs could be detected by chromatographic analysis. The apples were irradiated with a dose of 40,000 r which caused ripening of the fruit, and with a dose of 200,000 to 400,000 r, which sterilized the fruit. On irradiating apples with a dose of 40,000 r, the monosaccharide content decreased, while the starch content increased. The sucrose content fell to zero at a dose of 400,000 r. After storage for a month, the monosaccharide content in the irradiated apples was less than that in the unirradiated apples. A chromatographic analysis showed that the content of galactic acid was increased in the irradiated apples due to the break-down of pectin-like materials. The maltose and lactose contents were much lower, while the contents of fructose and glucose were higher after irradiation than before irradiation of the apples. The data show that irradiation has an effect on the carbohydrate content of plants that varies from plant to plant. The reasons for the differences in stability of the various carbohydrate components in different plants are not known at present. (TTT)

**28733** RESISTANCE PRODUCED IN MICE BY EXPOSURE TO IRRADIATED SCHISTOSOMA MANSONI CERCARIAE. Myron G. Radke and Elvio H. Sadun (Walter Reed Army Inst. of Research, Washington, D. C.). Exptl. Parasitol., 13: 134-42(Apr. 1963).

Studies were undertaken to determine whether $\gamma$ irradiation of cercariae might provide a means of investigating some of the mechanisms involved in the acquired resistance to schistosomiasis. Control mice received 200 non-irradiated cercariae, and other groups received the same number of cercariae that had been exposed to 6 different doses of $Co^{60}$ $\gamma$ irradiation varying from 1000–20000 rep. Eight weeks later the worms recovered were counted. Doses of 4000 rep or higher completely inhibited the development of schistosomes. A few stunted and underdeveloped worms were found in some of the mice receiving cercariae irradiated at 2500 and 3000 rep. Some adult schistosomes were observed in the groups receiving 1500 and 2000 rep and eggs were found in the liver but not in the stools of some mice. However, all of the mice exposed to cercariae irradiated with 1000 rep had eggs in liver and stools. The worm burden decreased regularly with increasing dosages up to 3000 rep, beyond which no worms were found at necropsy. The decrease in the number of worms mice acquired was linear only when cercariae were exposed from 1000 to 2000 rep, however, even beyond such dosages, it followed a straight line when the logarithm of irradiation dose was plotted. Acquired resistance to S. mansoni was observed in mice following a previous exposure to irradiated cercariae. (TCO)

**28734** EFFECTS OF X-IRRADIATED TUMOR CELLS ON SPONTANEOUS MAMMARY TUMOR RECURRENCES IN C3H MICE. John R. Mitchell (Yale Univ., New Haven). Growth, 26: 47-52(Mar. 1962).

Spontaneous breast tumors were removed surgically or by radiotherapy, from C3H mice and the rate of local recurrence was tabulated with and without intraperitoneal implantation of lethally x-irradiated (10000 r) isologous breast tumor cells. The incidence of recurrence was 100% in animals treated with radiotherapy (2 doses of 2500 r at a 1 week interval) without inoculation of x-irradiated cells. When lethally x-irradiated cells were inoculated, the recurrence rate was reduced to 77%. When the primary tumor was removed surgically, the control recurrence rate was 30%, while in animals receiving intraperitoneal x-irradiated cells it was increased to 53%. Thus, injections of irradiated cells exerted a beneficial effect on tumor-bearing mice subjected to radiotherapy and a harmful effect on those treated surgically, as far as recurrences were concerned. The increased recurrence rate after surgery following injection of irradiated tumor cells supports the previous suggestions that cancers are stimulated by cell death. (TCO)

**28735** THE BIOLOGICAL EFFECT OF COSMIC RADIATION. A. A. Gyurdzhian. Iskusstv. Sputniki Zemli, Akad. Nauk SSSR, No. 12, 77-104(1962).

A review on the biological effects of cosmic radiation is presented and includes discussion on: the relative biological activity (REA) of the various rays; characteristics of the biological effects of ionizing particles of cosmic radiation; characteristics of ionization of body tissues cosmic radiation particles; the biological effect of the heavy particles of cosmic radiation; genetic effect; combined effect of cosmic radiation and other factors present during space flight; problems of general biology; the experimental (on Earth) study of the biological effect of cosmic radiation; study of the biological effect of cosmic radiation in flight experiments; and biological experiments on space ship-sputniks. (TCO)

**28736** HOMOLOGOUS INHIBITION, TOXICITY, AND MULTIPLICITY REACTIVATION WITH ULTRAVIOLET-IRRADIATED VACCINIA VIRUS. G. J. Galasso and D. G. Sharp (Univ. of North Carolina, Chapel Hill). J. Bacteriol., 85: 1309-14(June 1963).

Vaccinia virus whose plaque-forming capacity had been destroyed by ultraviolet rays (2,537 A) was shown to retard the growth of L cells in tube cultures. At input multiplicities (M) of $0 < M < 10$, no interference was detected, but at $M \geq 100$ the irradiated virus particles exerted a strong toxic effect on the L cells in monolayer cultures, affecting the plaque formation by active virus which was added. Multiplicity reaction occurs in sublethally irradiated vaccinia, as shown by virus particle counts via electron microscopy and plaque counts. It is clearly demonstrated in this system because there is no complicating interference. It sets in at a total virus particle multiplicity of about one, even though the multiplicity of the original plaque-forming particles is much below one. (auth)

**28737** GENETIC EVIDENCE OF X-RAY-INDUCED EXCHANGES OCCURRING AT A FOUR-STRAND STAGE IN DROSOPHILA SPERMATOCYTES. S. Zimmering (Brown Univ., Providence). J. Heredity, 53: 254-6(Sept.-Oct. 1962).

Evidence is presented that x-ray-induced exchanges between X and Y chromosomes occur at a 4-strand stage in spermatocytes D. melanogaster. The evidence consists of the recovery of certain exceptional female progeny that received both of their X chromosomes from the irradiated male parent, one of these being a crossover and the other a noncrossover chromosome. XYY males were employed, the X chromosome of the male carrying the mutants y (yellow body) and v (vermilion eyes). Such males were irradiated at 800 r within 6 to 10 hr after the onset of the prepupal stage. The most advanced cells in the testis at the prepupal stage are primary spermatocyte at or immediately prior to the first meiotic division. Within 24 hr after eclosion, individual males were mated with $w^a$ (apricot-eye) attached-X females not carrying a free Y chromosome. Females receiving both X chromosomes from the irradiated parental male were recovered, each female being derived from a different male. One of the 4 v, each of the 2 $yvB^s$, and 7 of the 8 yv females recovered proved fertile. Females were made heterozygous for each of the presumed crossover chromosomes, $yvy^+$ and $yvB^s$, respectively, with an X chromosome bearing inversions to prevent effective crossing-over and having the composition $ysc^{+11}In^{49}wsc^{+3}$. These females were mated by ywf males. From each of the heterozygous females, only 2 classes of males and 2 classes of females appeared, namely, v and yw males and wild-type and yw females from the former, and $yvB^s$ and yw males and $yB^s$ and yw females from the latter. (TCO)

**28738** THE ASSOCIATION OF THYROID CANCER AND PRIOR IRRADIATION IN INFANCY AND CHILDHOOD. Raymond G. Rose, James E. Hartfield, Mavis P. Kelsey, and Eleanor J. Macdonald (Univ. of Texas, Houston). J. Nucl. Med., 4: 249-58(July 1963).

Review of the literature has revealed a growing volume of reports associating irradiation of the thymus or of the head and neck area, during infancy and adolescence, with subsequent development of cancer of the thyroid. Of the 426 individuals with thyroid cancer seen at The University of Texas M. D. Anderson Hospital and Tumor Institute from 1944 through 1961, 216 replied to questionnaires concerning prior irradiation. Of this number, 70 reported a positive history of preirradiation. Acne was the most common reason given for therapy. The latent interval between irradiation and onset of cancer averaged 12 years. Both of the children under 10, thirteen of the 17 patients under 15, and twenty of the 33 patients under 20 years of age at time of diagnosis of thyroid cancer had a history of previous irradiation. The evidence gathered to date is provocative enough to suggest caution in the use of irradiation in the management of benign conditions of the head, neck, and chest in infants and children. (auth)

**28739** INFLUENCE OF PLASMA FROM A VARIETY OF STRESSED ANIMALS ON $I^{131}$ UPTAKE IN CHICK EMBRYOS. Franklin T. Brayer (Georgetown Univ., Washington, D. C.). J. Nucl. Med., 4: 312-19(July 1963).

Plasma from rats, guinea pigs, and rabbits exposed to whole-body x irradiation when injected into 15 day old chick embryos elicits a significant increase in the $I^{131}$ uptake of the thyroid. The time post x irradiation when the exposed animal is bled is critical to the elicitation of the phenomenon. No threshold dose was determined in the rat for this phenomenon. The thyroid and pituitary glands seem to be essential in order to elicit the response while the adrenal is not. Plasma from rats subjected to the stress of violent exercise or abnormal environmental temperatures does not consistently elicit the phenomenon. Plasma from starved rats causes a significant depression in the $I^{131}$ uptake in the chick embryo. (auth)

**28740** OBSERVATIONS CONCERNING THE PROTECTIVE ACTION OF PANTOTHENIC ACID AGAINST RADIATION. Istvan Szorady, Gyorgy Toth, and Istvan Gazdag (Medical Univ., Szeged). Kiserl. Orvostud., 15: 134-6 (Apr. 1963).

Preliminary tests indicated that the life span of mice exposed to whole body irradiation may be lengthened by a prior treatment with pantothenic acid. It may be assumed that the mechanism of the protective action is dependent on the effect of pantothenic acid on the protection of the epithelium and the capillary walls, and its activating role in tissue regeneration, protein synthesis, antibody production, and corticoid synthesis, and also its general antiallergic properties. (OTS)

**28741** LABORATORY AND CLINICAL OBSERVATIONS WITH COMBINED ACTINOMYCIN D AND X RADIATION. Giulio J. D'Angio (Harvard Medical School, Boston). Laval Med., 34: 137-9(Jan. 1963). (In English)

From Symposium on Radiosensitivity, Laval Univ., Quebec, Sept. 1962.

The hair follicle of the mouse was used as a test object to assess the epilatory effects of combined actinomycin D and x radiation. Hair loss occurred earlier and in a higher proportion of animals given combined therapy than in those

receiving either one alone. In the studies on Ridgway osteogenic sarcoma in AKR or $AKD^2F^1$ mice, better survival and more pronounced tumor growth rate suppression was achieved by the combination as compared with results after treatment with either alone. The combined effect was independent of the sex of the animal; the parenteral route employed for administration of actinomycin D; the sequence in which the 2 treatments are administered; and the time interval separating the 2 up to 24 hr. In clinical studies with actinomycin D, it was noted that a patient receiving combined actinomycin D and x radiation developed x ray induced erythema after a skin dose of less than 200 r. Similar augmented reactions were seen in mucous membranes. Another phenomenon noted with relative regularity was the reactivation of latent radiation effects. Of 13 children with widespread metastases who received combination treatment, 5 remained free of disease for 4 years or longer since the last evidence of metastasis. It is postulated that use of the combination leads to inhibition of synthesis of both portions of a mutually dependent DNA-RNA system. (TCO)

**28742** EFFECT OF HUMAN BLOOD SERUM ON THE SURVIVAL OF X-IRRADIATED MICE. K. Rak, F. Krizsa, E. Soevenyu, and I. Cserhati. Magy. Radiol., 15: 98-101 (Apr. 1963).

White mice of both sexes weighing 20 to 25 g were subjected to whole-body x irradiation with 550 r. The animals were given injections of thrombopoietic human blood serum 48 and 24 hr before exposure. Data obtained after a 30-day observation period showed that the serum exerted a significant protective action, increasing the life span, survival rate, and thrombocyte count. (TCO)

**28743** MATING ABILITY OF MALE MOSQUITOES, AEDES AEGYPTI L., STERILIZED CHEMICALLY OR BY GAMMA RADIATION. Donald E. Weidhaas and Claude H. Schmidt. Mosquito News, 23: No. 1, 32-4(Mar. 1963).

The results of research comparing the effectiveness of sterilization of males by irradiation and sterilization by apholate in reducing the reproductive potential among caged populations of the yellow fever mosquito, Aedes aegypti L., are presented. (Public Health Eng. Abstr., 43: No. 6, June 1963)

**28744** RADIATION SKIN REACTION AND DEPLETION AND RESTORATION OF BODY IMMUNE RESPONSE. B. Jolles and R. G. Harrison (General Hospital, Northampton, Eng.). Nature, 198: 1216-17(June 22, 1963).

If a depilated rabbit's flank is exposed to a dose of 800 r followed immediately by an injection of pontamine sky blue into the marginal ear vein, a sharply defined blue flush appears after 2 hr and persists for 24 hr, reappearing 9 and 16 days after irradiation. The blueing effect, indicating an increased capillary permeability, confirms the view that cellular or tissue changes precede vascular reaction to irradiation. The blueing effect is absent when rabbits have received a total-body dose of 600 r in 20 min and then at different time intervals had their flanks exposed to 800-r doses followed immediately by injection of pontamine sky blue. The blue flush appears only when the second irradiation followed by blueing was done immediately or 5 to 7 days after total-body irradiation. Nitrogen mustard was as effective as total-body irradiation in preventing the blue flush effect. The skin response observations are interpreted in terms of immunology. (D.L.C.)

**28745** INTRINSIC NON-PROTEIN SULPHYDRYL LEVELS AND CELLULAR RADIOSENSITIVITY. László Révész, Helena Bergstrand, and Hans Modig (Karolinska Inst., Stockholm). Nature, 198: 1275-7(June 29, 1963).

The nonprotein sulfhydryl (NP–SH) level was measured in a series of cell lines which was derived from a common cell population (Ehrlich ascites tumor) and which displayed differing radiosensitivities. Increased NP–SH content per cell was generally associated with an increased average cell volume. The results indicate that increased NP–SH level per cell is associated with increased resistance to anoxic radiation, while no effect was noted for irradiation in oxygen. Possible causes of the increased NP–SH levels are discussed. (D.L.C.)

**28746** EFFECT OF IONIZING RADIATION ON THE BLOOD-BRAIN BARRIER. B. Iv. Iordanov and S. Bozhinov. Nevrol. i Psikhiatr., 1: No. 4, 26-37(1962).

Rats received 400 r whole-body x irradiation and the passage of hemic $Na^{24}$, $Br^{82}$, $K^{42}$, $H_2^3O$, $I^{131}$, and $Cr^{51}$ into the central nervous systems was compared with controls. The highest passage was into the pituitary gland and the least into the spinal cord. Permeability of the barrier was most pronounced at 24 hr post-irradiation with a gradual decrease. Comprehensive details are presented. (TCO)

**28747** GENERALIZED HYPEROSTOSIS INTERNA AND OSTEOSARCOMA IN WHOLE-BODY IRRADIATED MICE WITH HORMONALLY ACTIVE OVARIAN TUMORS. H. Cottier, H. Keller, and B. Roos (Universität, Bern). Pathol. Microbiol., 24: 276-7(1961). (In German)

Inbred mice, a Swiss albino subline, at the age of 3 months were submitted to a single, 600-r, whole-body dose of x radiation. Many of the irradiated females developed, with a peak incidence at 12 months, generalized hyperostosis interna as seen by replacement of the blood-forming bone marrow by newly formed bone of the spongiosa type. This finding was consistently accompanied by the development of hormonally active, dyplastic or neoplastic ovarian tumors, consisting of granulosa cells or so-called clear cells. Their estrogenic activity was reflected by changes in uterus and vagina, and their androgen secretion by changes in submaxillary glands and kidney (organs with androgen-dependent sexual dimorphism). All animals with clear-cut generalized hyperostosis interna showed signs of persistent and/or excessive estrogen secretory activity. The animals with most severe replacement of marrow by bone showed signs of increased androgen production along with hyperestrogenism. This was accompanied by hypertrophy of the inner zone of adrenal cortical cells. This bone pathology was significantly more frequent in irradiated than nonirradiated females or irradiated males with osteogenic sarcoma. After decalcification, bone samples from hyperostosis interna showed a higher iron content, on the basis of the Turnbull or Berlin blue reactions, than normal bone. (H.H.D.)

**28748** THE DEPENDENCE OF VIABILITY EFFECTS CAUSED BY IRRADIATION ON THE TYPE OF MATING. Raphael Falk and Ana Rahat (Hebrew Univ., Jerusalem). Proc. Natl. Acad. Sci. U. S., 49: 292-8(Mar. 1963).

The daughters of irradiated males and unirradiated control males were mated individually to two types of males of Drosophila melanogaster. The viability of males hemizygous for the irradiated chromosomes and of females heterozygous for the irradiated chromosomes was determined together with the corresponding control values. While the viability of males hemizygous for irradiated chromosomes was always reduced, the viability of females heterozygous for irradiated chromosomes was either reduced or increased, depending on the type of mating. Intraculture competition differences were demonstrated to be responsible for the difference between matings. The heterotic effect was observed whenever the females het-

erozygous for the irradiated chromosome were able to replace the decline in the number of males hemizygous for irradiated chromosomes. The observed heterosis was therefore spurious, in that it was not in fact the effect of a viability of the heterozygote superior to that of either homozygote. It is suggested that some previous reports on differences in mutability between types of crosses or on heterosis of flies heterozygous for induced mutations were also caused by intraculture competition. (auth)

**28749** CONSERVATION OF A VIRAL RNA GENOME DURING REPLICATION AND TRANSLATION. R. H. Doi and S. Spiegelman (Univ. of Illinois, Urbana). Proc. Natl. Acad. Sci. U. S., 49: 353-60(Mar. 1963).

In an attempt to get an answer to the question of conservation, the RNA of mature virus particles was doubly labeled by growth in the presence of $N^{15}$ and $P^{32}$. The RNA recovered after completion of lysis was banded in gradients of $Cs_2SO_4$. The two isotopes were recovered in the same RNA strands, corresponding in density to the $N^{15}$–RNA originally injected. The experiments were carried out under conditions which avoided the ambiguity which would be generated by the presence of nonparticipating strands or inactive virus particles. The data are consistent with the conclusion that the parental strands of an RNA virus are completely conserved during all the replications and translations required to produce a full yield of mature virus particles. Since it is very likely that the incoming viral RNA must serve as a genetic message, the results indicate that instability is not a mandatory attribute of RNA molecules which serve as programs for protein synthesis. (auth)

**28750** THE DEVELOPMENT OF SOMATIC MUTATIONS IN MICE WITH AGE. Cathryn Crowley and Howard J. Curtis (Brookhaven National Lab., Upton, N. Y.). Proc. Natl. Acad. Sci. U. S., 49: 626-8(May 1963). (BNL-6856)

Chromosome aberrations in the liver cells of two strains of mice, one long-lived and the other short-lived were measured as a function of age. The development of aberrations was found to be inversely proportional to the life expectancy. This result, together with other recent evidence, makes it seem very likely that somatic mutations play a dominant role in the aging process. (auth)

**28751** FORMATION OF ADENINE BY ELECTRON IRRADIATION OF METHANE, AMMONIA, AND WATER. Cyril Ponnamperuma, Richard M. Lemmon, Ruth Mariner, and Melvin Calvin (Ames Research Center, Moffett Field, Calif. and Univ. of California, Berkeley). Proc. Natl. Acad. Sci. U. S., 49: 737-40(May 1963).

The possibility of the synthesis of heterocyclic bases from mixtures of primitive gases was investigated. Results are reported on the synthesis of adenine by electron irradiation of a mixture of methane, ammonia, and water. Carbon-14 was used as a tracer. An inverse relation between the amount of adenine synthesis and amount of hydrogen gas present was observed. It was concluded that adenine is the most readily synthesized under prebiotic conditions of the five nucleic acid bases. (C.H.)

**28752** PHYSICAL ASPECTS OF BREAST RADIOGRAPHY. Leonard Stanton (Lankenau Hospital, Philadelphia), David A. Lightfood, James J. Boyle, Jr., and John E. Cullinan. Radiology, 81: 1-16(July 1963).

An attempt is made to provide a physical basis for selection of the most useful mammography technics. The effect of varying technical factors on image quality was evaluated both theoretically and experimentally. Over 1,500 test roentgenograms were made with a specially constructed phantom breast, with variations in technique. Both visual and photocell methods were used to evaluate roentgenographic contrast and detail. In addition, patient dosage was determined for various technics, using an instrument designed specifically for the purpose. The conclusions thus obtained provide the basis for design of new technics for differential diagnosis and mass survey studies of breast disease. (auth)

**28753** MEDICAL APPLICATIONS OF SOLID STATE RADIATION DETECTORS. Norman H. Horwitz (Veterans Administration Hospital, Dearborn, Mich.; Wayne State Univ., Detroit; and Detroit Memorial Hospital); James E. Lofstrom and Edward R. Powsner. Radiology, 81: 132-3 (July 1963).

Medical applications of silicon surface barrier detectors are discussed. The use of these detectors in scanning skin lesions for the detection of malignant tumors after the administration of a tracer dose of $P^{32}$ and in scanning thyroid tissue after a diagnostic dose of $I^{131}$ is described. (C.H.)

**28754** EXAMINATION OF RADIOPROTECTIVE EFFECTS OF DIFFERENT SUBSTANCES BY ENZYMATIC AND HISTOCHEMICAL ANALYSIS. Karl-Heinz Kaercher (Universität, Hiedelberg). Strahlentherapie, 121: 83-96(May 1963). (In German)

The behavior of malic dehydrogenase in serum and tissue homogenates as well as the behavior of the leucinaminopeptidase in serum, urine, and tissue homogenates under the influence of trioxyethylrutin, trasylol, and torantil is reported using whole-body irradiated rats. Histochemical investigations were done on liver, small intestine, and kidneys of the irradiated animals. It was found, that trioxyethylrutin and trasylol have a protective effect on liver and intestine, which is reflected in the behavior of the enzyme activity. Torantil (histaminase) shows reinforcing influence upon the results of the radiation influence. (auth)

**28755** MITOTIC EFFECTS OF IONIZING RADIATION ON THE VIRULENT AND MILD EPIDERMAL HYPERPLASIA OF MICE. PART III. GENERAL IMPORTANCE OF PATHOLOGICAL MITOSES IN MOUSE EPIDERMIS. Kai Setaelae, Bjoern Lindroos, and Otto Nyyssoenen (Univ. of Helsinki). Strahlentherapie, 121: 97-114(May 1963). (In German)

A comparison was made of the mitotic behavior in three different conditions of the same target tissue, the mouse epidermis: In malignant epidermal hyperplasia (provoked by the carcinogen 9,10-dimethyl-1,2-benzathracene) characterized by low mitotic activity as well as by delayed and misguided cell maturation, in benign epidermal hyperplasia (provoked by the tumor enhancer Tween 60) characterized by extremely high mitotic rate and by almost normal cell maturation, and in simple regenerative epidermal hyperplasia (caused by wounding of the skin with a razor blade). In parallel experiments, mice of RA strain (mice resistant to skin-tumor evolution) and mice of Swiss CF 1 strain (mice highly susceptible to skin-tumor evolution) were used. In each animal in each series, 500 mitoses (normal or pathologic) were registered. The material comprised a total of 50 000 mitotic figures. The occurrence of pathologic mitoses in the mouse epidermis is not an expression of an already existing malignant process; their appearance is not correlated to the intensity of the cell renewal; instead their occurrence is largely strain-dependent; neither the occurrence of mitotic aberrations nor their morphology can be used as criteria in estimations of possible specific effects of noxious agents, as just the same aberrations appear in the target tissue after exposure to carcinogen,

tumor enhancer, radiomimetics, the hypnotic sodium pentobarbital, ionizing radiation, or mechanical wounding of the skin. The results indicate that a number of previously uncontrolled factors must be accounted for in the evaluation of mitotic disturbances. (auth)

**28756** CYTOLOGICAL INVESTIGATIONS OF THE EFFECTS OF IONIZING RADIATION ON NORMAL, REGENERATING, AND BLASTOMATOUS TISSUE. PART I. IMPORTANCE OF A DYNAMIC-MORPHOLOGICAL METHOD OF ANALYSIS FOR THE BIOLOGY OF RADIATION EFFECTS. Heinz Karl Parchwitz (Universität, Bonn). Strahlentherapie, 121: 115-23(May 1963). (In German)

Problems occurring with the radiation reaction of cells of different tissues during the division resting state are discussed and the importance of the mitotic cycle is pointed out. The problems mentioned are discussed with a dynamic-morphological approach. (P.C.H.)

**28757** INVESTIGATION OF A BIOLOGICAL RADIATION PROTECTION. PART II. THE EFFECTS OF CHEMICAL RADIATION-PROTECTION MATERIAL FOR IN VITRO IRRADIATION OF CATTLE SERUM ALBUMIN SOLUTION. Ruprecht Koch and Fritz Staehler (Universität, Freiburg i. B.). Strahlentherapie, 121: 129-40(May 1963). (In German)

In vitro investigations concerning radiation protection were done with 1% solutions of bovine serum albumin using a dose between 1 and 6 million r. Using the ultracentrifugal pattern the percentage of unchanged albumin showed the protective effect. Sulfur-containing substances investigated were: cysteine, thioglycol, thiourea, thiomalonic acid, BAL-sodiumsulfonate, 5-mercaptopyridoxine, and 5-mercaptomethylpyridine. Aromatic substances investigated were: adrenaline, tyramine, histamine, nicotinamide, Na-benzoate, synkayvite, serotonin, tryptamine, and tryptophan. All substances show a radiation protective effect. It was obvious, that 15 to 23 moles are necessary to protect 1 mole of albumin, independent of the chemical structure. The problems of the hydrogen transfer as a protection mechanism and the importance of the SS- and SH-groups in the albumin molecule are discussed. (auth)

**28758** X-RAY-INDUCED INJURIES IN SKIN. Guenter Stein (Universität, Bonn). Strahlentherapie, 121: 247-58 (June 1963). (In German)

The definition of the phenomenon radiation damage or the state caused by the influence of ionizing radiation is given. Damage particularly of such areas as the skin is discussed. Early review papers as well as papers and reports of recent years dealing with this problem are given in tables. Finally, the observations are discussed and demonstrated. (auth)

**28759** ON THE QUESTION OF THE BIOLOGICAL DOSE EQUIVALENTS OF $Co^{60}$ GAMMA AND 200-Kv X RADIATION. [PART] II. Walfried A. Linden (Universität, Gottingen). Strahlentherapie, 121: 259-62(June 1963). (In German)

Forty rats each received a fractionated irradiation with 200 Kv x-rays and with $Co^{60}$-γ-rays, respectively, on a 6 cm long region of the tail. Total doses of 8000 to 12000 r were given. On the 36th day after the first irradiation photographic evaluation of the experiment was done. Between 10,000 and 11,000 r γ-rays produced a rise in the radiation effect. Some of the animals showed only a small reaction at a dose of 11,000 r. Comparing the effects of 200 Kv x rays and $Co^{60}$ γ-rays, an RBE value of 0.73 to 0.75 for the $Co^{60}$-γ-rays was estimated. (auth)

**28760** ON THE INFLUENCE OF WHOLE-BODY X IRRADIATION ON THE ACTIVITY OF LACTIC ACID DEHYDROGENASE IN BLOOD SERUM AND ORGAN EXTRACTS OF RATS. [PART] 2. Carlos Amoroso, Werner Lorenz, Heinz Lossen, and Helmut Oswald (Universität, Mainz). Strahlentherapie, 121: 269-80(June 1963). (In German)

Lactic dehydrogenase (LDH) content of serum, as well as in extracts of skeleton muscle, heart muscle, lungs, skin, brain, kidney, liver, small intestine, spleen, and testes of total-body x irradiated rats, was determined. The determinations were done on the 3rd day after irradiation with 1 × 1000 r or between the 3rd and 120th hour after irradiation with 10 × 100 r. The LDH content was decreased in serum, in skeleton muscle, and in small intestine 3 days after irradiation with 1 × 1000 r, while it increased in the testes. In comparison with the non-irradiated organ the LDH content in the small intestine was considerably decreased after 10 × 100 r; in the other organs the LDH content showed indefinite oscillations. There was no correlation between the LDH content of an organ and its radiation sensitivity in our experimental rats. There was also no correlation between the extent of the morphological damage of one organ and its LDH displacement in the irradiated animals. (auth)

**28761** RADIOBIOLOGICAL INVESTIGATIONS WITH CHROMIUM-LABELED ERYTHROCYTES. I. ON THE QUESTION OF INTRAPERITONEAL BLOOD TRANSFUSIONS. Hans-Joerg Mauss and Hans A. Kuenkel (Universität, Hamburg). Strahlentherapie, 121: 281-93 (June 1963). (In German)

The 100 year old history of the intraperitoneal blood transfusion is surveyed. Experiments with animals using chromium labelled erythrocytes are reported. More than 90% of the erythrocytes administered intraperitoneally appears in the peripheral blood of rats within 5 days. Hyaluronidase reduces the time of resorption to 24 hours. X-ray irradiation has no influence on the resorption process. The resorption time is about 8 days in hibernated dormice compared to 5 days in the awaken state. The survival time of the erythrocytes is after intravenous or intraperitoneal transfusion the same within the error limitations. (auth)

**28762** STRONTIUM-90 IN HUMAN TEETH. [PART] I. Rudolf Keil, Friedrich Randow, and Hans-Arthur Schulze (Universität, Rostock, Ger.). Strahlentherapie, 121: 294-8(June 1963). (In German)

A collection of human teeth from the age of 5 years upward was measured radiochemically. An average content of 0.55 pc $Sr^{90}$/g calcium was found for this material according to the observed impulse rates of $Y^{90}$ oxalate precipitation. (auth)

**28763** THE COMBINED USE OF N(4-NITROPHENYL)-BENZAMIDINE AND BONE MARROW TRANSPLANTATION AFTER WHOLE-BODY IRRADIATION OF RATS. Dimiter G. Zographov and Ilia A. Baev (Radiobiologische Forschungsbase, Sofia). Strahlentherapie, 121: 299-303(June 1963). (In German)

The effectiveness of combined use of N(4-nitrophenyl)-benzamidine and bone marrow transplantation after single total-body irradiation of female rats was investigated using lethality and changes in body weight as measurements. The survival rate in the control group was 8%; it was 40% for that group where the animals were treated with bone marrow only, 52% for the chemically protected rats, and 72% for the combined treated animals. The weight changes show that the synergism of both methods is a result of a decreased radiation sensitivity of the organism by chemical

radiation protection substance and a stimulation of bone marrow regeneration by the transplantation. (auth)

**28764** PROTECTIVE EFFECTS OF ETHYLPALMITATE ON X-IRRADIATED MICE. Kurt Flemming and Christa Flemming (Universität, Freiburg i. B. and Heiligenberg-Instituts, Heiligenberg Baden, Ger.). Strahlentherapie, 121: 304-11(June 1963). (In German)

An ethyl ester of palmitic acid (ethylpalmitate) increased the survival rate of x irradiated mice, if it was injected intravenously in small doses 24 to 72 hours before irradiation. This protective effect could be shown also by measuring the effect on body weight after irradiation. The radiation protective effect of the ethylpalmitate was obtained at 25 to 100 mg/animal; it was dose dependent and increased with increasing dose. The toxicity of ethylpalmitate was tested using non-irradiated mice. The mortality increased from about 5% to 85% in the dose range of 25 to 100 mg/animal; female animals were more sensitive than male ones. Purest ethylpalmitate was more toxic than ethylpalmitate of less purity. The problem is discussed whether chemical splenectomy caused by the ethylpalmitate is responsible for the radiation protection effect of this substance. (auth)

**28765** ON THE NATURE OF MUTATIONS IN MAIZE. Angelo Bianchi (State Univ., Milan). Strahlentherapie, Sonderbaende, 51: 4p.(1962).

Procedures are described for use in the study of mutagenesis in maize. Data are included from studies of spontaneous, radioinduced, and chemically induced mutations in maize. (C.H.)

**28766** MORPHOLOGICAL AND CYTOLOGICAL STUDY OF HUMAN AMNION CELLS IN THE COURSE OF RECOVERY FROM RADIATION INJURY. Masahiro Mizutani, Yuh H. Nakanishi, and C. M. Pomerat (Univ. of Texas, Galveston). Texas Rept. Biol. Med., 19: 811-24(1961).

Human amnion cells (Fernandes strain) cultured in vitro were irradiated with 1000-r doses of $Co^{60}$ γ rays and examined by staining techniques for the next 5 days. The number of cells in the control cultures increased until a plateau was reached at 4 days, then began to decrease, whereas irradiated cultures showed a progressive decrease in cell numbers during the 5-day period. Mitotic index in nonirradiated cultures reached a max on the first day, then showed a gradual decrease. In the irradiated cultures, the mitotic activity of the cells was remarkably inhibited on the first day, suddenly increased on the second day, and reached max on the third day, after which the mitotic index fell rapidly. The later higher values may result from the accumulation of the cells at metaphasic stage. In most metaphasic figures the chromosomes showed abnormalities. These severe chromosomal aberrations might inhibit migration of chromosomes to the poles at anaphase, so that metaphasic cells underwent degeneration in this condition without advancing further. Control cultures showed a constant value of giant cells at 5 days, and irradiated cultures reached a max on the third day after irradiation. The incidence of giant cells on the second day was higher in the irradiated cultures than in the controls. The number of multinucleate cells, consisting of both giant and nongiant elements, significantly increased in irradiated cultures, as compared with that in control cultures. A gradual shift in the modal value of chromosomes toward lower numbers with successive passages of cultures is suggestive of selective adaptation. (H.H.D.)

**28767** IN VIVO CHANGES IN UROCANIC ACID OF GUINEA PIG AND HUMAN EPIDERMIS BY ULTRAVIOLET LIGHT. J. Hill Anglin, Jr. Thesis, Norman, Okla., Univ. of Oklahoma, 1962. 46p.

Control skin and skin irradiated with ultraviolet light (UV) were examined for chemical differences resulting from the UV irradiation. It was found that acid extracts of skin exposed to three minimal erythema doses of UV from a hot quartz mercury vapor lamp possess a marked decrease in the specific UV absorbency in the 260 mμ portion of the spectrum. It is shown that the decrease in specific UV absorbency is due largely to decreased amounts of urocanic acid in the extract. It is further shown that almost half of the urocanic acid isolated after irradiation is the cis isomer. Only the trans modification was found in normal, non-irradiated extracts. A method for separation of the cis and trans isomers of urocanic acid, using ion exchange methods, is outlined. The infrared absorption spectra of cis and trans urocanic acid isolated from skin is presented with similar spectra for the authentic trans isomer and in vitro prepared cis urocanic acid. The cis isomer of urocanic acid from UV irradiated skin was characterized by melting point, mobility in paper chromatographic systems, color formation with diazotized aromatic amines, and UV absorption spectra characteristics. Infrared absorption data support present assignment of cis and trans configurations in these substances. (Dissertation Abstr. 23: May 1963)

**28768** RADIOISOTOPES AND IONIZING RADIATIONS IN ENTOMOLOGY. Bibliographical Series No. 9. (International Atomic Energy Agency, Vienna). 1963. 418p. $8.00, Sch 168, 48s. stg, NF 32, DM 28 (IAEA). (STI/PUB/21/9)

References from the open literature from 1950 to 1960 are presented on applications of radioisotopes and ionizing radiations in entomology. Data are appended on the dispersal of radioisotope-labeled insects, radiation sterilization of insects, references for the synthesis of labeled insecticides and related compounds, and references to tracer studies on the metabolism of organophosphate insecticides by plants. (C.H.)

**28769** RADIATSIONNAYA BIOKHIMIYA. (Radiation Biochemistry). A. M. Kuzin. Moscow, Publishing House of the Academy of Sciences, 1962. 336p.

The effects of ionizing radiation on biological materials are discussed. Radiation effects on water, albumen, carbohydrates, vitamins, nucleic acids, and nucleoprotein are investigated. The effects on the condition and metabolism of living cells and tissue are also investigated. (C.E.S.)

**28770** GISTO-GEMATICHESKIE BAR'ERY I IONIZIRUYUSHCHAYA RADIATSIYA. (Histo-Hematological Barriers and Ionizing Radiation). Moscow, Publishing House of the Academy of Sciences, 1963. 216p.

The importance of immediate nourishment to combat radiation effects in organs, tissues, and cells is discussed. Changes in the histamine and serotonin content and their role in the penetrability changes in histo-hematological barriers are considered. In particular the hemato-encephalitic and hemato-ophthalmic barriers are discussed. (C.E.S.)

## Radiation Sickness

**28771** EFFECT OF ORGANIC PHOSPHATES ON THE COURSE AND OUTCOME OF THE ACUTE RADIATION DISEASE. G. Kotev, A. Andreev, and A. Maleev. Eksperim. Med. i Morfol., 1: No. 3, 42-7(1962).

Ten dogs x irradiated with a single dose of 600 r all died within 2 to 3 weeks, whereas only 2 died out of 15

that received tabun oil solution 10% of $LD_{100}$ (0.05 mg./kg.) daily s.c. for 10 days starting 15 min after irradiation. Also, only 2 died of 5 receiving 5% of $LD_{100}$ for 15 days. Leukopenia in tabun-treated dogs was hardly less intense than in controls at 8 to 21 days post-irradiation; hemoglobin did remain higher all along, cholinesterase was low as expected from tabun but symptoms were probably less. Presumably organic phosphates and radiation partly involve the same enzymatic mechanism but in an antagonistic fashion. (OTS)

**28772** PROTECTIVE EFFECT OF OZONE IN MICE AGAINST WHOLE-BODY X-IRRADIATION. Keiko Hattori, Norio Kato, Masahiro Kinoshita, Syosaku Kinoshita, and Tsuyoshi Sunada (Radiation Centre of Osaka Prefecture, Osaki). Nature, 198: 1220(June 22, 1963).

Adult male albino mice were exposed to 1 ppm ozone for 1 hr and then irradiated with 800-r x rays after 10 days. About 60% of the treated animals survived while all of the untreated controls died within 30 days. Similarly, exposure to 2 ppm ozone for 0.5 or 0.25 hr and irradiation by 550 r ($LD_{50/30}$) 24 hr later gave complete protection. The tolerance induced by ozone lasted 30 days or more. (D.L.C.)

**28773** EFFECT OF CHLORINATION OF DRINKING WATER ON MORTALITY AFTER WHOLE-BODY X-IRRADIATION. A. Sassen, G. Mattelin, F. Kennes, and J. R. Maisin (Centre d'Étude de l'Énergie Nucléaire, Mol, Belg.). Nature, 198: 1318(June 29, 1963).

Mice were exposed to single x-ray doses and antibiotics (chlortetracycline and nitrofurazone) administered for 15 days after exposure in conjunction with chlorinated water (5 to 10 ppm). Chlorination was found to increase the lethal dose. Similar results were obtained for rats. (D.L.C.)

**28774** THE EFFECTS OF A SINGLE WHOLE-BODY IRRADIATION ON THE GROWTH AND OSTEOGENESIS OF THE HOUSE MOUSE (MUS MUSCULUS DOMESTICUS RUTTY 1772). H. Scheufler (Universität, Halle, Ger.). Naturwissenschaften, 50: 403-4(1963). (In German)

Mice were irradiated on the day of their birth with x-ray doses of 570 r, measured in air. An arrest in growth appeared in one day. The body weight of the controls increased 0.15 g in one day, while that of the irradiated animals increased only 0.04 g. After 100 days the irradiated mice weighed only 48% as much as unirradiated mice. Bone growth was studied in the same mice. (M.C.G.)

**28775** IDENTIFICATION OF THE IMMUNE SYSTEM RESPONSIBLE FOR THE SPECIFICITY OF ACTIVELY ACQUIRED TOLERANCE IN MICE. Gino Doria (Oak Ridge National Lab., Tenn.). Proc. Natl. Acad. Sci. U. S., 49: 281-6(Mar. 1963).

Tolerance to CBA/Cum skin was induced in C3H/Anf Cum mice by neonatal injection of CBA/Cum spleen cells. The tolerant status of these mice was a specific one, for they were able to produce a normal amount of agglutinins against a challenge dose of rat RBC. The immune system responsible for the specificity of tolerance in these mice was identified to be of host type. No immune activity of donor cells against rat RBC could be detected, whereas donor type antigenicity was found in the spleen of the tolerant mice. On the basis of these findings it was proposed that the definition of tolerance given for the whole animal could also be applied to its immune system. (auth)

**28776** ON THE QUESTION OF RADIOTOXINS. Kurt Fochem (Universität, Vienna). Strahlentherapie, 121: 124-8(May 1963). (In German)

An attempt was made to transfer the radiation syndrome of x irradiated rabbits to non-irradiated control animals in several series and to prove it by using changes in the leukocyte count, albumin-globulin-ratio, and capillary permeability. It was felt that this would contribute to the question of whether radio-toxins exist. Furthermore, the importance of effective liver shielding for prevention of radiation sickness could be pointed out using the animal experiments. (auth)

**28777** ZNACHENIE FAKTORA PITANIYA V PROFILAKTIKE LUCHEVOI BOLEZNI. IV. TRUDY INSTITUTA. XXVIII. (Value of Nutrition in Prophylaxis of Radiation Sickness). Riga, Publishing House of Academy of Sciences, Latvian SSR, 1962. 256p.

Morphological changes in animals from the effects of gamma radiation were investigated. Systematic inspection was given to lymphatic tissue, fat cells, eosinophilic leukocyte, nerve systems, and elements in the blood. Characteristics of the disrupted chemical concentration in organs and tissue were investigated in relation to the stage of nourishment. The liver, muscles, and skin were also analyzed. Changes in vitamin content and biochemical hematosis were reported. The role of nourishment and albumin reserve in the prevention of radiation sickness was investigated. (C.E.S.)

# CHEMISTRY

## General and Miscellaneous

**28778** (CISE-96) SCAMBIO CATIONICO CON ARGILLE ATTIVATE. PARTE I. CARATTERISTICHE DEI MATERIALI E PREPARAZIONE DELLO SCAMBIATORE CATIONICO. PARTE II. SEPARAZIONI CHIMICHE. PARTE III. EFFETTO DEL TRATTAMENTO TERMICO E DELLA IRRADIAZIONE GAMMA SULLA SUPERFICIE INTERNA E SULLA CAPACITA DELLE MONTMORILLONITI ACIDE. (Cationic Exchanger with Activated Clay. Part I. Characteristics of the Materials and Preparation of the Cationic Exchanger. Part II. Chemical Separation. Part III. Effect of Thermal Treatment and Gamma Irradiation on the Internal Surface and Capacity of Acidic Montmorillonite). E. Cerrai, C. Ronchetti, and C. Triulzi (Centro Informazioni Studi Esperienze, Milan). May 1963. 41p.

The preparation of an acidic cationic exchanger from a calcium bentonite is described. The behavior and properties of acidic montmorillonite and activated clay are given as well as the effect of thermal treatment and gamma irradiation on cationic exchange capacity and internal surface area. (auth)

**28779** (MCW-1480) PROCESS DEVELOPMENT QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1963. (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). May 1, 1963. Contract W-14-109-eng-8. 29p.

A spectrochemical method utilizing a copper fluoride carrier was developed for the determination of boron in magnesium in the range of 0.2 to 3.0 ppm. Precision at 0.3 ppm boron is ±0.05 ppm at the 95% confidence level. Further laboratory work on direct electroreduction of uranium dioxide was made. Uranium tetrafluoride concentration in the fused salt electrolyte has a major effect on cell throughput. Electron microprobe analysis was conducted for aluminum and silicon concentration gradients across the bond layer of a type OIIIN uranium core and its aluminum–silicon braze. (auth)

**28780** (AEC-tr-5853) TETRA CARBON MONOFLUORIDE, A NEW GRAPHITE-FLUORINE COMPOUND. Walter Rudorff and Gerda Rudorff. Translated by Hal H. Stone (Oak Ridge National Lab., Tenn.) from Chem. Ber., 80: 417-23(1947). 13p.

Preparation, properties, and structure of tetracarbon monofluoride are described. Graphite reacts in a fluorine stream laden with hydrogen fluoride at room temperature with the formation of an until now unknown graphite–fluorine compound, whose composition was within the boundaries $C_{3.6}F$ to $C_{4.6}F$. At 100°C and higher temperatures this reaction ceased. The compound is characterized by inertness. Crystal structure of the compound is discussed. The compound is compared with carbon monofluoride and graphite bifluoride. (N.W.R.)

**28781** THE ION-EXCHANGE BEHAVIOUR OF BERYLLIUM SALICYLATE COMPLEXES. H. J. de Bruin, J. J. Fardy, and R. B. Temple (Australian Atomic Energy Commission, Sutherland, New South Wales). Australian J. Chem., 16: 376-91(June 1963).

The beryllium/salicylate system was re-examined by ion-exchange procedures. The results appear to confirm the existence of a neutral 1:1 and an anionic 1:2 complex, in both of which the salicylate radicals form chelate rings. Conditional stability constants were measured at 25°C at an ionic strength of 0.15, the values obtained being $\beta_1 = 4.97 \times 10^{12}$, and $\beta_2 = 2.63 \times 10^{22}$. (auth)

**28782** RAMAN AND INFRARED SPECTRA OF $BF_3$ COMPLEXES WITH DIETHYL ETHER AND TETRAHYDROFURAN, AND THE ISOTOPIC EXCHANGE OF THESE COMPLEXES WITH $BF_3$. G. M. Begun and A. A. Palko (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 38: 2112-17(May 1, 1963).

The Raman and infrared spectra of $BF_3$·diethyl ether and $BF_3$·tetrahydrofuran were recorded for both the $B^{10}$ and $B^{11}$ compounds. The spectra were compared to that of $BF_3$·dimethyl ether and tentative assignments of the skeletal vibrations were made. The isotopic data were used to calculate theoretical equilibrium constants for isotopic exchange between the complexes and $BF_3$. The calculated values are slightly higher but compare quite well with published values of experimentally determined separation factors. (auth)

**28783** PHOTO-IONIZATION AND ELECTRON-CAPTURE PROCESSES IN SOLUTION: THE FLASH PHOTOLYSIS OF ETHER SOLUTIONS OF POTASSIUM METAL AND OF NAPHTHACENE DIANION. Jorma Eloranta and Henry Linschitz (Brandeis Univ., Waltham, Mass.). J. Chem. Phys., 38: 2214-19(May 1, 1963).

Flash excitation of solutions of potassium in tetrahydrofuran or dimethoxyethane leads to a new substance with a broad infrared absorption. This transforms rapidly to a second intermediate, which finally returns to the original state by a slow first-order process ($k = 12.8\ sec^{-1}$). These changes are interpreted as photodissociation of doubly trapped electrons ($e_2$) followed by fast recombination to a triplet state of $e_2$ and slower return of the triplet to the original singlet. Flashing solutions of naphthacene dianion yields the monoanion and near-infrared bands attributable to $e_1$. The recombination process is second-order ($k = 1.5 \times 10^9\ moles^{-1}\ sec^{-1}$). Much faster electron capture by neutral naphthacene is also observed. (auth)

**28784** SPECTROPHOTOMETRIC STUDIES OF URANIUM(VI) COMPLEX WITH RUTIN (QUERCETIN-3-RUTINOSIDE). Brahm Dev and B. D. Jain (Univ. of Delhi). J. Indian Chem. Soc., 40: 269-71(Apr. 1963).

Spectrophotometric studies of uranyl-rutin complex were carried out. Uranium forms with rutin an orange, water-soluble complex which obeys Lambert-Beer's law at 445 mμ within the concentration range of 1.19 to 23.80 ppm of uranium. The color intensity of the complex does not vary between pH 4.8 and 7.0. The molar composition of the complex shows that it contains uranium and rutin in the molar ratio of 1:2. The stability constant of the complex was determined by a method based on Beer's law. (auth)

**28785** COMPOSITION AND STABILITY OF LANTHANUM(III)-p-NITROBENZENEAZOCHROMOTROPIC ACID (CHROMOTROPE 2B) CHELATE IN SOLUTION. Satendra P. Sengal, Suresh C. Srivastava, and Arun K. Dey (Univ. of Allahabad, India). J. Indian Chem. Soc., 40: 275-8(Apr. 1963).

A detailed study of the composition and stability of lanthanum(III)-p-nitrobenzeneazochromotropic acid (chromotrope 2B) chelate was made spectrophotometrically. The chelate is reddish violet in color ($\lambda_{max}$ at 540 mμ). The composition, as determined by different methods, is 1:1 (metal:chelating agent). The chelate is stable between pH

5.0 and 12.5. The values of log K, as determined by two different methods, are 4.5 ± 0.1 and 4.9 ± 0.18 respectively at 25° and at pH 6.0. (auth)

**28786** COMPOSITION AND STABILITY OF THORIUM(IV)-1(o-ARSONOPHENYLAZO)-2-NAPHTHOL 3,6-DISULPHONATE (THORON) CHELATE. Satendra P. Sangal and Arun K. Dey (Univ. of Allahabad, India). J. Indian Chem. Soc., 40: 279-82(Apr. 1963).

Spectrophotometric studies on the composition and stability of the chelate formed between thorium and 1-(o-arsonophenylazo)-2-naphthol 3,6-disulphonate (thoron) was made at pH 3.0. The chelate is red in color with $\lambda_{max}$ at 515 mμ. The composition, as determined by different methods, is 1:2 (metal:chelating agent). The chelate is stable between pH 1.0 and 6.5. The values of log K, as determined by two different methods, are 9.4 ± 0.3 and 9.8 ± 0.2, respectively at pH 3.0 and at 25°. (auth)

**28787** ON THE AVERRED EFFECTS OF RADIOISOTOPIC TRACERS ON SOLUBILITY. R. W. Ramette and O. Anderson (Carleton Coll., Northfield, Minn.). J. Inorg. Nucl. Chem., 25: 763-70(July 1963). (In English)

Contrary to recent reports on the effects of radioactivity on various heterogeneous chemical processes, barium sulfate labeled with $S^{35}$ having specific activities of 5, 20, and 50 mC/g showed constant solubility of $1.15 \times 10^{-5}$ mole/l in water at 25°C. Calcium sulfate, labeled with $Ca^{45}$ having specific activities of 0.1, 0.2, and 1.0 mC/g showed constant solubility of 0.0151 mole/l. However, silver iodate, labeled with $Ag^{110}$, behaved as though the radioactivity induces breakup of the crystal surface into particles too small for ordinary filtration, and the effect seems to depend on specific activity in the range 0.04 to 6.0 mC/g. (auth)

**28788** FORMATION CONSTANTS OF WEAK COMPLEXES: THE 1:1 COMPLEXES OF MALATE WITH ALKALI METAL CATIONS IN AQUEOUS SOLUTION. Luther E. Erickson and Jay A. Denbo (Dickenson Coll., Carlisle, Penna.). J. Phys. Chem., 67: 707-9(Mar. 1963).

The formation constants $K_f$ of the alkali metal-malate complexes were obtained by pH measurements: $Li^+$, 2.8 ± 0.3; $Na^+$, 2.0 ± 0.3; $K^+$, 1.7 ± 0.2; $Rb^+$, 1.5 ± 0.2; and $Cs^+$, 0.8 ± 0.2 l/mole. When the results were plotted on a log $K_f$ vs $(Ze)^2/r$ graph along with values for $Ca^{2+}$, $Sr^{2+}$, and $Ba^{2+}$, a straight line is formed, in agreement with Born's model. The second dissociation constant of malic acid is reported to be $1.38 \times 10^{-6}$ mole/l. The relation of the results to other NMR investigations is discussed briefly. (D.L.C.)

**28789** THE SORPTION OF WATER VAPOR AND THE HYDROGEN–DEUTERIUM EXCHANGE EFFECT ON POLY-L-GLUTAMIC ACID. Wasyl S. Hnojewyj and Lloyd H. Reyerson (Univ. of Minnesota, Minneapolis). J. Phys. Chem., 67: 711-13(Mar. 1963).

The sorption of $H_2O$ and $D_2O$ by a polymer of L-glutamic acid was studied, and isotherms at 17, 27, 37, and 57°C were determined. It was found that this polymer can exchange only a little more than 80% of its labile hydrogens, and the monosite occupation amounts to less than this fraction of the hydrophilic sites. It is concluded that the structure of the polymer and the nature of the side chains determine its capacity for adsorbing $H_2O$ and exchanging its labile hydrogens. (D.L.C.)

**28790** HYDROLYSIS OF BIS-(ACETYLACETONATO)-BERYLLIUM(II). R. W. Green and P. W. Alexander (Univ. of Sydney). J. Phys. Chem., 67: 905-7(Apr. 1963).

Distribution of $Be^7$ between water and cyclohexane in the presence of excess acetylacetone at 25° was used to study the formation and hydrolysis of complexes between pH 4 and pH 11. At zero ionic strength, stability constants are log $\beta_1$ 7.96 and log $\beta_2$ 14.67. The mono-complex, $BeL(H_2O)_2$, undergoes two stages of acid dissociation with $pk_1 = 6.4$ and $pk_2 = 9.8$. (auth)

**28791** PERTECHNIC ACID: AN APERIODIC VARIATION IN ACID STRENGTH. Charles L. Rulfs, Roland F. Hirsch, and Richard A. Paces (Univ. of Michigan, Ann Arbor). Nature, 199: 66(July 6, 1963).

An aperiodic variation in acid strength was found in pertechnetic acid, $HTcO_4$. Possible factors involved are discussed. (C.H.)

**28792** CHEMISTRY IN NUCLEAR TECHNOLOGY. Sigfred Peterson and Raymond G. Wymer. Addison-Wesley Series in Nuclear Science and Engineering. Reading, Massachusetts, Addison-Wesley Publishing Company, Inc., 1963. 384p.

This book describes the important role of chemistry in nuclear technology, particularly in the areas of fuel cycle and materials technology. After a review of elementary chemical fundamentals, nuclear reactions, and radiochemistry, the chemistry of fission products, Th, Pa, U, and the transuranium elements are discussed. The technological chemistry of nuclear materials is next considered, including separations from ores, recovery from irradiated fuels, disposal of radioactive wastes, isotope separation, and chemistry of reactor materials. (D.L.C.)

**28793** METHOD FOR CONCENTRATING A WATERY SOLUTION OF ZIRCONIUM NITRATE. Samuel Zonis, J. Malone Norwood, E. Vincent Sherry, Jr., and W. Hicks Keller (to Columbia-National Corp.). German Patent 1,145,597. Mar. 21, 1963. Priority date May 14, 1959, United States.

The method comprises the steps of evaporating a solution which contains a little less than 50 g/l dissolved zirconium and is at a temperature of less than 104°C and under a pressure of less than 508 Torr, until the content of dissolved zirconium reaches 60 g/l, and of lowering the temperature of the solution afterwards below 79°C. The velocity of evaporation has to be chosen so that the average time the solution is at a temperature of more than 79°C is less than 60 minutes, preferably less than 30 minutes. (Gmelin Inst.)

**28794** METHOD FOR PREPARING $UO_2$ OF DEFINITE GRAIN SIZE. Marie Egidius Antonius Hermans and Theo van der Plas (to Stichting Reactor Centrum Nederland). German Patent 1,147,930. May 2, 1963. Priority date May 14, 1958, Netherlands.

A method is given for preparing $UO_2$ of definite grain size. A hot watery solution in which there are 0.4 g-ion per liter of uranyl ions, nitrate ions, and urea is stirred until homogeneity is achieved, then a homogeneous precipitation is performed, and at last the solid material is quickly separated from the still hot fluid and transformed into $UO_2$. In order to achieve a predetermined definite grain size, the precipitation has to take place in a solution which contains 110 to 200 g per liter urea and a nitrate ion concentration of less than 1.8 g-ions per liter, and which is at a temperature of less than 100°C, preferably 90° to 98°C. The resulting $UO_2$ grains can be heated in an atmosphere of water vapor whereby the structure of the particles is not changed. (Gmelin Inst.)

## Analytical Procedures

*Refer also to abstract 29171.*

**28795** (AEET/ANAL/5) VOLUMETRIC DETERMINATION OF URANIUM AFTER ITS SEPARATION BY TRI-

BUTYL PHOSPHATE EXTRACTION. L. M. Mahajan, N. R. Thakoor, and M. S. Varde (India. Atomic Energy Establishment, Trombay). 1963. 13p.

Volumetric determination of uranium, down to 0.1 mg of $U_3O_8$, is described for samples containing high amounts of thorium and other interfering elements. Uranium is extracted with 5% tributyl phosphate in kerosene from a 2N–$HNO_3$ solution. The organic phase is scrubbed with saturated ammonium nitrate. The uranium is back extracted with ammonium carbonate solution and estimated volumetrically, after reduction in a Jone's reductor, using standard ceric sulphate solution and ferroin as the indicator. The method has been applied for the determination of uranium in a variety of minerals. (auth)

**28796** (AEET/ANAL/7) SPECTROGRAPHIC DETERMINATION OF TRACES OF TANTALUM AND TITANIUM IN NIOBIUM OXIDE AND OF TITANIUM AND NIOBIUM IN TANTALUM OXIDE. L. C. Chandola, A. P. D'Silva, and U. R. N. Swamy (India. Atomic Energy Establishment, Trombay). 1963. 9p.

A spectrographic method is described for the estimation of tantalum oxide and titanium oxide in the range 0.05 to 2% on a niobium oxide base and also for the estimation of niobium oxide and titanium oxide in the range 0.025 to 2% on a tantalum oxide base. Spectra are excited in an intermittent a-c arc and photographed on a large quartz spectrograph. The lines at 3081.77 and 2683.22 Å, due to Nb in the niobium oxide matrix are used as the internal standard lines; the corresponding analytical lines being Ti 3078.65 and Ta 2685.11 Å. In the tantalum oxide matrix the lines Ta 2943.77 and Ta 3182.57 Å are used as the internal standard lines for analytical lines Nb 2950.88 and Ti 3186.45 Å respectively. (auth)

**28797** (AEET/ANAL/8) POLAROGRAPHY RECOMMENDED AS A STANDARD METHOD FOR ESTIMATION OF COPPER, NICKEL AND CHROMIUM IN STEELS. V. T. Athavale, R. G. Dhaneshwar, and M. M. Mehta (India. Atomic Energy Establishment, Trombay). 1963. 17p.

Following published polarographic methods, statistical data were collected for the estimation of copper, nickel and chromium in samples of standard steels (British Chemical Standards) of different composition. This was done to study reliability and reproducibility of the polarographic methods for routine analysis. The results of polarographic estimation were found to be in good agreement with the chemical values reported. (auth)

**28798** (AEET/ANAL/9) SPECTROGRAPHIC DETERMINATION OF HIGH AMOUNTS OF CALCIUM IN URANIUM METAL BY THE SPARK METHOD. A. B. Patwardhan and B. N. Shrinivasan (India. Atomic Energy Establishment, Trombay). 1963. 8p.

A spark spectrographic method is described for the estimation of calcium in uranium in the range 0.02 to 0.5%. 100 micro liters of uranyl nitrate solution of 9 mgms of U per ml was deposited on ¼ in. graphite electrodes, dried and sparked by high voltage a-c spark. The spectra were photographed on a 3.4 meter Ebert spectrograph having 15000 lines/inch grating. Ca(I) 4226.7 Å and U 4228.8 Å were used as analytical and internal standard lines. A working curve for the concentration range 0.02 to 0.5% was drawn which gives an average deviation of about 6%. (auth)

**28799** (AEET/ANAL/10) A RAPID AND SIMPLE METHOD OF ESTIMATION OF URANIUM IN MINERALS AND ORES BY PAPER STRIP CHROMATOGRAPHY. N. Mahadevan and Ch. Venkateswariu (India. Atomic Energy Establishment, Trombay). 1963. 11p.

A method was standardised for the fast estimation of uranium in minerals and ores. The sample is dissolved with a mixture of hydrofluoric and nitric acids. After removing fluoride with repeated nitric acid evaporations, uranium is separated on a paper strip using ethyl acetate or tri-n-butyl phosphate in mineral turpentine as solvent. The estimation is carried out by comparing the colour intensity developed with potassium ferrocyanide with known standards. (auth)

**28800** (CEA-2095) DOSAGE DE L'IODE DANS LES MILIEUX BIOLOGIQUES AU MOYEN DE L'ANALYSE PAR RADIOACTIVATION. (The Determination of Iodine in Biological Media Using Radioactivation Analysis). Dominique Comar (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 64p.

It is shown that radioactivation analysis of iodine in biological media makes it possible to measure iodine concentrations of the order of 0,0001 μg. A review of the chemical methods and the difficulties they present, along with the optimum conditions for the determination of iodine in biological liquids are given. Three methods are described. The sensitivity, reproducibility, and accuracy are also discussed. Some applications are described: determination of iodine in its various organic forms in serum, determination of iodine in urines, food-stuffs, and thyroid tissue. (P.C.H.)

**28801** (IDO-14316(Suppl.4)) [SUPPLEMENT NO. 4 TO MANUAL OF THE ANALYTICAL METHODS USED BY THE CONTROL LABORATORY AT THE CHEMICAL PROCESSING PLANT]. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). [nd]. Contract [AT(10-1)-205]. 202p.

Twenty-six analytical methods are given. Elements and radicals covered include: Ca, Co, Cd, Mg, Mn, Ni, Zn, Pb, Sn, B, Al, Cl, I, U, Zr, nitrite, nitrate, sulfate, peroxide, and TBP. (M.C.G.)

**28802** (PG-Report-433) MANUAL OF ANALYTICAL METHODS FOR TRICHLORETHYLENE. (United Kingdom Atomic Energy Authority. Production Group, Capenhurst, Ches., England). 1963. 87p.

Collected Capenhurst methods for analysis and determination of trichlorethylene are presented. Safety notes and precautions are given. Standard specification tests are outlined. Nine chemical analytical methods are described. Miscellaneous tests on residues and sludges are included. (M.C.G.)

**28803** (AEC-tr-5867) USE OF A "PLASMA-BURNER" AS A SPECTROCHEMICAL EXCITATION SOURCE. K. H. Neeb and W. Gebauhr. Translated for Ames Lab., Ames, Iowa from Z. Anal. Chem., 190: 92-7(1962). 7p.

A d-c plasma burner, similar to that described by Owens, was constructed for flame-photometric analysis. The operation of the burner is described, and the results of analysis of low concentrations of magnesium are given. (D.L.C.)

**28804** NEW ASPECTS OF RADIOACTIVITY MEASUREMENTS; ISOCHRONIC MEASUREMENTS AND MEASUREMENTS OF CONTROLLED DURATION. J. Cl. Philippot. Bull. Inform. Sci. Tech. (Paris), No. 70, 75-86 (Mar. 1963). (In French)

This aspect of radioactivity measurements makes it possible, by using the data connected with the half lives of the elements measured, to shorten considerably the time necessary for the evaluation of the quantity of a given radioelement in a mixture of many. Several possible aspects of the measurements are considered, and the case of a mixture of the two types of radioactivity (natural and artificial) present on a filter, was examined from the point

of view both of the $\beta$ and the $\gamma$ measurements. The measurement method proposed remains general, however, and is applicable each time that the half lives of radioactive substances in a mixture are known and are fairly different from each other. (auth)

**28805** ACCOUNT OF THE UTILIZATION OF CONTROL SOURCES FOR COUNTING. M. Granier. Bull. Inform. Sci. Tech. (Paris), No. 70, 87-8(Mar. 1963). (In French)

Pill-shaped U control sources are used in conjunction with ZnS(Ag) scintillation detectors in order to standardize the electronic equipment associated with the scintillation detector. The detector is designed for the determination of Rn in the air in U mines. (T.F.H.)

**28806** SPECTROPHOTOMETRIC INVESTIGATION OF THE REACTION OF GLYCINE CRESOL RED WITH HYDROGEN AND COPPER(II) IONS FOR DETERMINATION OF TRACE AMOUNTS OF COPPER IN URANIUM. B. Budešínskii (Budesinsky) and J. Gurovič (Inst. for Nuclear Physics, Czechoslovak Academy of Sciences, Řež). Collection Czech. Chem. Commun., 28: 1154-61(May 1963). (In German)

The dissociation constants of the proton complexes of glycine cresol red were determined. In addition, the composition of the Copper (II) complexes of this dye, the value of its association constant for various pH, and its apparently universal stability constant were ascertained. A process for the selective determination of copper traces (3 to 80 $\mu$g) in uranium was developed. (tr-auth)

**28807** THE EXTRACTION OF THE NIOBIUM SALT OF PYRROLIDINEDITHIOCARBAMINATE. I. M. Gibalo, I. P. Altmarin, and P. Davaadorzh (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 149: 1326-7(Apr. 21, 1963). (In Russian)

The ammonium salt of pyrrolidinedithiocarbaminate (PDT) was synthesized from pyrrolidine with the use of tetrahydrofuran as a starting material. This compound was used as an analytical reagent to recover Nb from a solution containing ~1 mg/ml of $Nb_2O_5$ and 2 to 3% of tartaric, citric, or oxalic acids. $Nb^{95}$ was used as a tracer. Experiments with 2 to 30 mg of $Nb_2O_5$ showed that the niobium salt of PDT is precipitated quantitatively from the tartaric and oxalic acid solutions in the form of a white amorphous precipitate with a 20-fold excess of reagent in the presence of an acetate buffer at a pH of 4 to 5. The extraction of the Nb salt of PDT with chloroform is quantitative from a weak acid solution (pH of 4 to 5), and from concentrated HCL (8.5 to 10 N). Citric acid, fluorine, and sulfate interfere with the extraction. The extraction should be repeated 2 to 3 times after adding a 15- to 20-fold excess of reagent in order to obtain quantitative extraction of the niobium. This solvent extraction method can be used to separate niobium from tantalum, titanium, zirconium, tungsten, beryllium, the rare earths, and other elements. (TTT)

**28808** GAS CHROMATOGRAPHIC SEPARATION OF DEUTERIUM-SUBSTITUTED OLEFINS BY UNSTABLE COMPLEX FORMATION. R. J. Cvetanović, F. J. Duncan, and W. E. Falconer (National Research Council, Ottawa). Can. J. Chem., 41: 2095-7(Aug. 1963). (NRC-7403)

A method using $AgNO_3$–ethylene glycol–firebrick is described for separation of deuterated olefins. The column was very effective for separation of $C_3H_6$ from $C_3D_6$ and $C_2H_4$ from $C_2H_2D_2$ and $C_2D_4$ at –16°C. Slight improvements in separation were observed upon lowering the column temperature. For a given retention time longer columns give better peak resolution. (P.C.H.)

**28809** SPECTROPHOTOMETRIC DETERMINATION OF IRON, NICKEL, AND CHROMIUM TRACES IN REACTOR DIPHENYL. D. Monnier, W. Haerdi, and E. Martin (Université, Geneva). Helv. Chim. Acta, 46: 1042-6 (1963). (In French)

In order to determine traces of Ni, Cr, and Fe in diphenyl, approximately 1 g of the organic compound is mineralized, after sublimation of the major part of the diphenyl, with concentrated $H_2SO_4$ and $HNO_3$. The $HNO_3$ should be distilled before use to reduce its iron concentration. It was possible to determine 6.0 ppm of Fe and 0.2 ppm of Cr in fresh diphenyl. 7.1 ppm of Fe, 1.6 ppm of Cr, and 0.8 ppm of Ni could be determined in diphenyl after 17 days in an irradiation loop exposed to an intermittent flux of $6 \times 10^{11}$ n/cm$^2$/sec. (tr-auth)

**28810** COMPUTERS IN ACTIVATION ANALYSIS. Barney T. Watson (Veterans Administration Hospital, Omaha). J. Nucl. Med., 4: 306-11(July 1963).

The activation analysis of samples of blood serum is described in which a 400-channel analyzer and IBM-1620 Fortran computer program are used for analysis of data. The basic assumption in the neutron activation analysis system is that the spectra of irradiated elements in a composite sample add linearly when counted with a multichannel analyzer. The proportionate parts of a composite spectrum may be assigned to the proper element by solving a set of simultaneous linear equations of order K of the number of radioactive elements in the composite. Results of analyses for Ca, Mn, and Mg are compared with results using chemical analysis. Accuracy and limitations of the method are discussed. (C.H.)

**28811** GAMMA-RAY SPECTROMETRIC ANALYSIS OF SOME TRACE ELEMENTS IN THE HUMAN ARTICULAR DISC OF THE MANDIBLE. Bo Bergman and Rune Soeremark (Royal School of Dentistry, Stockholm). Nucl. Med., 3: 175-82(1963). (In English)

By means of neutron activation and gamma spectrometry the concentrations in the human mandibular articular disc of the following elements were determined: Na, Mn, Cu, Zn, Rb, Sr, Cd, W, and Au. The discs were obtained at necropsy from seven men and nine women, ranging in age from 56 to 71 years. The activation was carried out in a thermal neutron flux of about $1.7 \times 10^{12}$ n cm$^{-2}$ sec$^{-1}$ for about 20 hr. A chemical group separation was performed before the gamma ray spectrometry. Quantitative data based on the dry weight of the cartilage samples were obtained by comparing the photopeak area of the identified elements with those of appropriate standards. (auth)

**28812** DETERMINATION OF TRACE ELEMENTS IN OPIUM BY MEANS OF ACTIVATION ANALYSIS. I. METHODS OF ANALYSIS AND STUDIES REFERRING TO THE DETERMINATION OF THE ORIGIN OF OPIUM. Alexis C. Pappas (Univ. of Oslo), Jorolf Alstad, and Gulbrand Lunde. Radiochim. Acta, 1: 109-17(June 1963). (In English)

The gold and lanthanide content in samples of opium ash was studied using neutron activation analysis. The gold content was found to vary from about 0.5 to 10 ppm and the total rare earth content from about 20 to 150 ppm. Large variations were found in the distribution pattern of the individual rare earths in opium samples from different origin. The results are discussed and indicate that activation analysis may be used to indentify the origin of opium samples. (auth)

**28813** ACTIVATION ANALYSIS OF MINERAL IMPURITIES IN TERPHENYLS AND THEIR DETERMINATION

BY $\gamma$ SPECTROMETRY. G. Aubouin (CEN, Grenoble, France). Radiochim. Acta, 1: 117-23(June 1963). (In French)

The analytic procedure described aims at the determination of 15 radioelements derived from 13 inactive elements present as traces in the terphenyls: Al, Cl, Ni, Mn, Cu, Na, Zn, Ga, Sb, Cr, Fe, Sc, and Co. Details are given on the irradiation, chemical separations after mineralization, and quantitative determinations. The results are discussed, especially with respect to perturbations by the irradiation; the limit sensitivities are given for conditions corresponding to the utilized technique. Those sensitivities are, following the elements, between $5 \times 10^{-6}$ and $10^{-9}$ g. (auth)

**28814** ACTIVATION ANALYSIS DETERMINATION OF IMPURITIES IN ALUMINUM. II. DETERMINATION OF COPPER AND DYSPROSIUM. W. Kiesl, H. Bildstein, and F. Hecht (Universität, Vienna). Radiochim. Acta, 1: 123-5 (June 1963). (In German)

A method for the selective extraction of copper is described. It is based on the fact, that cuprous ions form a complex with 2,2'-diquinolyl which is extractable by amyl alcohol. Copper is re-extracted into the aqueous layer by nitric acid and precipitated by benzoinoxime, and the 051-Mev peak (annihilation radiation) is measured. Dysprosium is determined, without destruction, after short-time irradiation by measuring the 91-kev peak. (auth)

**28815** SEMIQUANTITATIVE MICRODETERMINATION OF URANIUM BY MEANS OF FLUORESCENCE ON PAPER—APPLICATION TO RAPID ANALYSIS IN NATURAL WATER. G. Alberti, G. Grassini, and E. Di Ferrante (CNRN, Rome). Studi Ric. Div. Geomineraria, Comit, Nazl. Ric. Nucl., 3: 455-74(1960). (RT/GEO(63)10). (In Italian)

A method for the semiquantitative microdetermination of uranium in natural waters is described. The method is based on the uv fluorescence obtained when a salt of uranium reacts on paper with sodium triphosphate and zinc acetate. The reaction can still detect 0.001 $\gamma$ of uranium in a dilution of $1 \times 10^6$ and thus is much more sensitive than the usually employed reaction with ferrocyanide. Samples of natural waters (0.4 to 10 ml) are concentrated by evaporation onto the chromatogram. The uranium is then separated from interfering ions by ascending development with hexone-$HNO_3$. The time required for a determination depends on the concentration of uranium (concentration of sample) and is 45 minutes for >25 $\gamma$/l and 3 hr for <25 $\gamma$/l. Since only a mineral light lamp and a hairdryer are used, the analysis can be carried out in the field. (auth)

**28816** THE DETERMINATION OF URANIUM AND THORIUM. Handbook of Chemical Methods for Their Determination in Minerals and Ores. (Gt. Brit. Dept. of Scientific and Industrial Research). 1963. 49p. 3s. 6d. (HMSO).

A review is presented on break-down of the sample and the separation and determination of thorium and uranium. The procedures selected are conditioned by several factors, for example, nature of the material, concentration of uranium or thorium present, and the demands imposed by the requirement of a very high accuracy on the one hand or for rapid, but less accurate results on the other. (P.C.H.)

**28817** A VERY SENSITIVE FLUORESCENCE TEST FOR URANIUM AND ITS USE IN THE PAPER CHROMATOGRAPHIC ESTIMATION OF URANIUM IN NATURAL WATERS. Giuliana Grassini and Giulio Alberti (Universitä, Rome). p.285-91 of "Proceedings 1961 International Symposium on Microchemical Techniques." Rome, J. Wiley & Sons, Inc., 1963. (RT/CHI(63)17)

When uranium (VI) reacts with zinc acetate and sodium phosphate on filter paper, a green fluoresence is observed under ultraviolet light. The reaction can detect even 0.001 $\mu$g of uranium at a dilution of $1:10^6$ and is much more sensitive than the ferrocyanide reaction usually employed. Detection of uranium in the presence of interfering ions and the application of the new test in geochemical prospecting are discussed. On the basis of the reaction a rapid semiquantitative method for the determination of uranium in natural waters was worked out. (P.C.H.)

**28818** METHOD OF DETERMINING THE CONTENT OF DEUTERIUM HYDRIDE IN HYDROGEN. Johann von Grotthuss, Karl Jaeger, and Heinz Karwat (to Gesellschaft für Linde's Eismaschinen AG). U. S. Patent 3,090,672. May 21, 1963. Priority date Dec. 8, 1958, Germany.

A method of determining the deuterium hydride content of a sample of technical H by measuring thermal conductivity is patented. The technical H is first freed of impurities by freezing or adsorption at low temperatures. Then the ratio of ortho- to para-hydrogen is adjusted to ortho-para equilibrium at the temperature of the thermal-conductivity-measuring apparatus. This is done by passing the sample over an ortho-para equilibrium-establishing catalyst. The ratio of ortho- to para-hydrogen in the reference H in the comparison chamber of the thermal-conductivity apparatus is also adjusted to equilibrium. This prevents an ortho-para ratio transformation at the measuring apparatus, which would cause an incorrect thermal-conductivity indication. Specific methods, catalysts, and examples are described. (M.P.G.)

## Inorganic and Physical Chemistry

**28819** (AD-405844) INTERMEDIATE STATE REORIENTATION OF COBALT-57 NUCLEI ALIGNED IN CERIUM ZINC NITRATE. Technical Report No. 4. W. W. Strohm, Jr. and R. C. Sapp (Kansas. Univ., Lawrence). May 15, 1963. Contract Nonr-2775(00). 24p.

Radiation patterns and the linear polarization of gamma rays from decay of $Co^{57}$ aligned at low temperatures by Bleaney's method in the Y-sites of cerium zinc nitrate were studied for evidence of intermediate state reorientation in this crystal. Incluence of spin-spin interactions should be negligible on theoretical grounds. Experimental results, expressed in terms of the mixing ratio $\delta = \pm\sqrt{(E2/M1)}$ for the 123 kev M1 + E2 gamma transition and of an attenuation coefficient $Q_k$ in the angular distribution $W(\theta) = \sum_{k\ even} Q_k A_k P_k(\cos\theta)$, are $\delta = +0.148 \pm 0.010$, $Q_2 = 0.81 \pm 0.10$ at $1/T^* = 157$. Comparisons are made with Steenberg's theory of intermediate state reorientation by static, isotropic hfs coupling in the hard core limit, and with results of another nuclear alignment experiment involving the same isotope. 26 references. (auth)

**28820** (AE-109) THE PROPERTIES OF $CaSO_4$:Mn THERMOLUMINESCENCE DOSIMETERS. Bengt Bjaerngard (Aktiebolaget Atomenergi, Stockholm). June 1963. 27p.

The properties of the radiothermoluminescence of $CaSO_4$:Mn, used for dosimetry of gamma and roentgen radiation, were investigated. The light yield of the luminophor was determined to 1.5% for 1 Mev gamma radiation. The dependence of the thermoluminescence light sum on the exposure, the exposure rate, and the exposure time can quali-

tatively be described by the first order process model, modified by a broad energy distribution of the electron trap depths. Some applications are discussed. The cheapness of the dosimeters, the convenient read-out, and the broad range of measurable exposures suggest that $CaSO_4$:Mn can be a valuable complement to other dosimetry systems. (auth)

**28821** (AERE-R-1182) THE EXTRACTION OF BERYLLIUM FROM BERYL BY FLUOROSILICATE. B. F. Greenfield, K. R. Hyde, F. H. Moore, J. M. Fletcher, and P. L. Robinson (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Mar. 1963. 27p.

Silicon tetrafluoride is known to be liberated in the Copaux process by which beryllium is obtained as a water-soluble compound by roasting beryl with a fluosilicate. The influence of conservation of silicon tetrafluoride in the system is reported for a variety of conditions: the variables studied have included temperature, pressure, time of heating, and the use of several alkali metal fluosilicates: the results support earlier work on the mechanism of the formation of water-soluble beryllium by this process. The process is tested in a rotating furnace and semi-continuously in a tunnel furnace. The latter gave good results. (auth)

**28822** (IA-813) DIFFERENTIATION BETWEEN Er I AND Er II SPECTRA USING ONLY A DC ARC AS EXCITATION SOURCE. (Spectral Ranges: 4218.43-4702.19 A and 4925.04-6557.78 A). S. Held (Israel. Atomic Energy Commission, Rehovoth). Jan. 1963. 23p.

The differentiation between Er I and Er II spectra in the regions 4218.43 to 4702.19 Å and 4925.04 to 6557.78 Å was made using only a d-c arc as excitation source. With few exceptions the assignments made are in agreement with existing data. In the spectral region under investigation, 265 lines, not classified so far, are identified as belonging to I or II spectra. (auth)

**28823** (KFK-134) SYNTHETISCHE ANORGANISCHE IONENAUSTAUSCHER. Literaturubersicht. (Synthetic Inorganic Ion Exchangers. Literature Survey). Heinrich J. Schroeder (Kernforschungszentrum. Institut für Radiochemie, Karlsruhe, Germany). Mar. 1963. 46p.

The 92 references on synthetic inorganic ion exchanges are arranged alphabetically by author under the following topics: salts of heteropoly acids; difficultly soluble hydrated oxides; difficultly soluble Zr, Ti, Sn, or Th compounds with the exception of the oxides; and other difficultly soluble compounds. An author index is included. (M.C.G.)

**28824** (LADC-5533) THE SHAPE OF THE F-ORBITAL FUNCTIONS. J. T. Waber and J. E. Hockett (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract [W-7405-eng-36]. 40p.

Accurate perspective drawings were prepared for the seven distinct angular portions of the f-electron wave functions and for the four related Kubic Harmonic functions. Stereographic projections were used to illustrate the angular positions of the nodes and the maxima of these functions. When these diagrams were considered in conjunction with the stereograms representing the radius vectors to ligand atoms or groups in five crystallographic arrangements, it was possible to deduce qualitatively the shifts in energy due to the crystal field splitting. The effects of spin-orbital coupling were assumed to be small in this simplified treatment. (auth)

**28825** (NAA-SR-8422) MELTING PROPERTIES OF SILVER NITRATE TO 10,000 ATMOSPHERES. B. B. Owens (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 30, 1963. Contract AT (11-1)-Gen-8. 11p.

The effects of pressure on the volume of fusion and the melting point of silver nitrate were determined up to 10,000 atmospheres. The extrapolated value for the volume of fusion at zero pressure is 2.58 cc/mole, as compared to the literature value of 0.3 cc/mole. On the basis of the Clausius-Clapeyron equation, a value of 2.54 cc/mole was calculated for the volume of fusion from the limiting slope of the melting curve at zero pressure and the calorimetric value for the heat of fusion. The effect of increasing the pressure to 10,000 atmospheres is to reduce the volume of fusion by 30% and to increase slightly the heat of fusion. (auth)

**28826** (NYO-10551) A MOLECULAR ORBITAL TREATMENT OF THE BONDING IN CERTAIN METAL-ATOM CLUSTERS. F. A. Cotton and T. E. Haas (Massachusetts Inst. of Tech., Cambridge). July 16, 1963. Contract AT(30-1)-1965. 30p.

The structures of the $[M_6X_8]^{4+}$, M = Mo, W(?), $[M_6Cl_{12}]^{2+}$, M = Nb, Ta, and $[M_3X_{12}]^{3-}$, M = Re, species, which contain clusters of heavy transition metal atoms are compared; and the occurrence of approximately square $MX_4$ units is noted as a common feature. The metal-metal bonding within the clusters is treated by a simple molecular orbital method, and it is shown that in this way all the general aspects of the electronic structures can be straightforwardly accounted for. Clues provided as to other possible metal ion cluster compounds are discussed. (auth)

**28827** (TID-17149) LITHIUM–BORON CARBIDE REACTION STUDIES. D. R. Secrist and W. J. Childs (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 10, 1962. Contract W-31-109-eng-52. 21p.

The reaction of lithium with boron, carbon, and boron carbide was studied. The results provide a basis for the evaluation of irradiated boron carbide, where the reaction $B^{10}(n,\alpha)Li^7$ occurs. A study of the phase relationships in the lithium–boron and lithium–carbon systems was made. Compositions containing from 3 to 55 atom % lithium were quenched after equilibration at temperatures between 350 and 1000°C. An x-ray analysis of the lithium-carbon compositions indicated that only one form of lithium carbide was present with either free graphite or lithium. A single crystal of $Li_2C_2$ was examined by the Weissenberg x-ray technique. The unit cell was identified as primitive monoclinic with lattice parameters $a_0 = 7.801 \pm 0.002$ Å, $b_0 = 8.815 \pm 0.005$ Å, $c_0 = 10.865 \pm 0.005$ Å, and $\beta = 76.8 \pm 0.1$ deg. With respect to the lithium-boron system, an x-ray analysis indicated the existence of a new phase, present in small quantities at 9-atom % lithium, and predominant at 32 atom % lithium. Chemical analyses suggested that lithium and boron may form the compound $B_{12}Li$. Boron carbide compositions containing from 7- to 71-atom % lithium were reacted at 600 and 700°C. Examination by x-ray, petrographic, and chemical methods indicated that both lithium carbide and lithium boride were formed. The boride reaction was predominant. (auth)

**28828** (TID-18951) BASIC RESEARCH IN INORGANIC AND PHYSICAL CHEMISTRY AT HIGH TEMPERATURES. Fifth Annual Report. A. D. Kirshenbaum and A. V. Grosse (Temple Univ., Philadelphia. Research Inst.). June 30, 1963. Contract AT(30-1)-2082. 40p.

The maximum-bubble-pressure method was used to measure the surface tension of liquid tin and sodium chloride over longer liquid temperature ranges than previously. The surface-tension equations obtained (dynes/cm) are:

$\gamma_{Sn} = 581.2 - 7.424 \times 10^{-2}$ T °K and $\gamma_{NaCl} = 188.8 - 7.75 \times 10^{-2}$ T °K. The surface tension of $UF_4$ and $ThF_4$ was measured in the same tubes over their whole normal-liquid ranges and that of liquid uranium over a 400° range. The values obtained have the following linear equations in respect to temperature: $\gamma_{UF_4} = 447.3 - 19.22 \times 10^{-2}$ T °K, $\gamma_{ThF_4} = 431.2 - 14.16 \times 10^{-2}$ T °K, and $\gamma_U = 2,246 - 37.83 \times 10^{-2}$ T °K. The density of liquid thorium was determined from its melting point (1968) to 2180°K. Extrapolation of the preliminary values gave a liquid density of 10.35 g/cm³ at the melting point and an expansion on melting of 5.6%. The solid density of antimony from 20°C to its melting point was determined and found to have the following relationship to temperature. $D_{(S)}$ in g/cm³ = $6.967 - 2.687 \times 10^{-4}$ (T − 299°K). Antimony expands 0.79 ± 0.14% on melting. The composition of the iron-carbon system was determined from 2585 to 3148°K and its viscosity determined. The composition of the uranium-carbon system was determined from 2820 to 3025°K and that of the zirconium-carbon system at 3125 to 3150°K. Several inorganic chemical reactions at high temperatures were studied. They include the synthesis of $ThB_6$ and the reactivity of liquid B with BN and liquid Mn with $ThO_2$. The centrifugal plasma-jet furnace was used to contain liquid Al near its boiling point and liquid B on Liquid $Al_2O_3$. Theoretical correlations were made between the activation energy of viscosity of liquid metals and their melting points. A comparison and discussion of the densities and critical constants of liquid barium and calcium were made. (auth)

**28829** (TID-18959) ELECTROLYTIC SOLUTIONS. Annual Progress Report, May 1, 1962–June 1, 1963. Jerry Braunstein (Maine. Univ., Orono). June 1, 1963. Contract AT(30-1)-2873. 22p.

Results of investigations of the thermodynamics of association in molten salts and in concentrated aqueous electrolyte solutions are reported. Association constants of Pb(II) with chloride or bromide and of Cd(II) with chloride or bromide in molten mixtures of $LiNO_3$ and $KNO_3$ were measured potentiometrically at several temperatures and compared with previous results in mixtures of $NaNO_3$ and $KNO_3$. The "anomalous" solvent effect of lithium ion, reported previously for the association of Cd(II) with bromide was observed also for the other associations and a tentative explanation is suggested. The temperature dependence of the association constants was found to be in agreement with the quasi-lattice model. The association constant of Ag(I) with iodide in molten mixtures of $NaNO_3$ and $KNO_3$ was measured and compared with previous results in pure $KNO_3$. The solvent effect was consistent with the "reciprocal coulomb effect." Techniques were developed, and preliminary results obtained for measuring association constants in the solvent system $KNO_3$–$Ca(NO_3)_2$ in order to investigate the effect of charge as well as size of solvent cation on association constants in molten salt solutions. The measurement of association constants in concentrated aqueous electrolyte solutions was continued. The association of Cd(II) with bromide in aqueous $LiNO_3$ was measured as part of a program to find a system that would lend itself to investigation over the range between anhydrous molten salt and aqueous electrolyte solution. Cells and electrodes were developed for investigating association constants in equimolar $LiNO_3$–$KNO_3$ with controlled small water contents, and preliminary results are reported. (auth)

**28830** (TID-18985) THE ELECTROCHEMISTRY OF A TWO-DIMENSIONAL HYDROGEN GAS. Technical Report Number XLII. Vernon Glen LeFebre, Carl J. Christensen, and Henry Eyring (Utah. Univ., Salt Lake City. Inst. for the Study of Rate Processes). May 31, 1963. Contract AT(11-1)-1144. 103p.

The behavior of a nickel wire electrode was found to be very similar to the behavior of the palladium electrode. When the nickel electrode was either solution oxidized, anodized, or vacuum annealed, the steady-state potential increased in the positive direction (European sign convention). Cathodization of the nickel electrode had the opposite effect, the potential decreased. This behavior can be explained if one assumes that the electrode potential of nickel, like palladium, is determined by the internal hydrogen concentration. A model is proposed to explain the effect of internal hydrogen on the electrode potential. The internal hydrogen is pictured as diffusing to the nickel-solution interface where it is adsorbed from the nickel interior onto the surface. While on the surface, the hydrogen atoms behave as a 2-dimensional van der Waals gas. An equation is derived which gives the surface coverage in terms of the internal hydrogen concentration. The surface coverage is then related to the electrode potential by a special form of the Nernst equation. Thus, the electrode potential is determined by the internal hydrogen concentration. Calculations using this model were made on data from the potential decay of palladium electrodes. During the decay process the internal hydrogen concentration decreases at a constant rate, and therefore, the time-potential plot of the data can be interpreted in terms of a hydrogen adsorption isotherm. A theoretical hydrogen adsorption isotherm which was calculated using the model, was compared with the experimental isotherm. The agreement was found to be within the experimental error. (auth)

**28831** (UCRL-10650) EFFICIENCY OF EQUATIONS OF STATE FOR GASEOUS MIXTURES AT THE CRITICAL LOCUS. I. APPLICATION OF THE EQUATION OF BENEDICT, WEBB, AND RUBIN. II. FURTHER IMPROVEMENTS OF AN EQUATION OF STATE (thesis). Frank Jay Ackerman (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 1, 1963. Contract W-7405-eng-48. 69p.

The critical state of gaseous mixtures is of practical interest in high-pressure reactions and petroleum engineering. A discussion of the critical state is appropriately based on the equation of state and rigorous thermodynamic relations. The eight-parameter equation of state proposed by Benedict, Webb, and Rubin was compared with observed data and a two-parameter equation of Redlich and Kwong. Contrary to expectation, the more elaborate equation furnished sometimes entirely unreasonable results. This failure was related to the fact that the values of the eight parameters are in general not sufficiently well defined by observations in a limited range of temperature and pressure. An algebraic equation of state is desirable because it leads shortly to fugacity coefficients, which are the practically important objective in the study of the variables of state. The advantages and shortcomings of the equation of Redlich and Kwong are discussed. The improved equation obtained comes close to the accuracy of Pitzer's tables and at the same time permits an algebraic derivation of fugacity coefficients. (auth)

**28832** (AEC-tr-5854) ON THE CATALYTIC INFLUENCE OF HYDROFLUORIC ACID ON THE FORMATION OF CARBON MONOFLUORIDE. Walter Rudorff and Gerda Rudorff. Translated by Hal H. Stone (Oak Ridge National Lab., Tenn.) from Chem. Ber., 80: 413-17(1947). 8p.

The carbon monofluoride formation by gaseous hydrogen fluoride catalysis explains the appearance of a carbon monofluoride coating on carbon and graphite anodes in fluo-

rine preparation through the electrolysis of potassium fluoride. Hydrogen fluoride melts when the temperature of the anode exceeds 250°C. On the basis of the difference in reactivity of flocculent graphite and coke oven graphite it may be predicted that in a potassium hydrogen fluoride melt the carbon monofluoride formation on graphite and carbon anodes occurs in somewhat the same measure so long as the temperature does not exceed 260–270°C. In melts with higher hydrogen fluoride content a stronger attack is found and therefore carbon anodes are to be given preference. (N.W.R.)

**28833** (AEC-tr-5866) OXIDES OF URANIUM. P. Lebeau. Translated by C. E. Schilling and Roger C. Mansfield (Oak Ridge National Lab., Tenn.) from Compt. Rend., 174: 388-91(1922). 4p.

Observations are given on the chemical properties of the oxides of U. The dark gray oxides are $U_3O_8$ and can be heated to 1000°C without decomposition. The colored oxides contain variable amounts of $UO_3$ and are susceptible to moist air. (D.L.C.)

**28834** (AEC-tr-5870) THE REACTION OF COMPLEX FORMATION IN THE CHEMICAL TECHNOLOGY OF URANIUM. E. E. Chernyaev and G. V. Ellert. Translated by C. E. Stevenson from Atomnaya Energ., 14: 383-94 (Apr. 1963). 20p.

The reactions of complex formation, applied to the basic technological operations in the chemical production of uranium-bearing materials, are described. Current data for the chemistry of coordination compounds of uranium are presented. It is shown that the overwhelming majority of reactions of solution, precipitation, and extraction of compounds of uranium appear to be reactions of complex formation of this element. There is described a view of the mechanism of a series of reactions of solution, precipitation, and extraction of compounds of uranium. (auth)

**28835** (SCL-T-483) SOME EQUILIBRIUMS OF HYDROGEN AND OF DEUTERIUM WITH CERIUM AND GADOLINIUM. Rodolphe Viallard. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from Ann. Chim. (Paris), 20: 5-72(Jan.-Feb. 1945). 73p.

Semi-metallic hydrides and deuterides are discussed. Methods of isotope exchange applicable to the study of these compounds are described. Equilibria between hydrogen isotopes and lanthanide elements were determined. The fixation of deuterium by cerium was observed to be the same as the fixation of hydrogen, even as low as room temperature. Both hydrogen and deuterium combined with gadolinium. The absorption of either gas became noticeable only above 150°C. At a temperature around 250°C, the absorption proceeded according to a mechanism governed by the phenomena of diffusion and dissociation within the solid mass which is in a process of evolution. The experiments showed that the exchange reactions studied proceed according to a mechanism that is comparable to the process which characterizes the isothermal fixation of hydrogen or deuterium by gadolinium while the fixation of hydrogen or deuterium by cerium displayed the characteristics of a genuine chemical reaction. (M.C.G.)

**28836** (SCL-T-486) ZIRCONIUM COMPOUNDS. VI. REACTION BETWEEN ZIRCONYL CHLORIDE AND OXALATES. Sadashige Takagi. Translated by Nobura Hiraga (Sandia Corp., Albuquerque, N. Mex.) from Nippon Kagaku Zasshi, 77: 1568-72(Oct. 1956). 12p.

Changes in the electrical conductivity at the time of titration of aqueous solutions of zirconyl chloride with oxalic acid or oxalates were determined, along with pH changes. The equivalent relations in precipitate formation and dissolution were investigated. The precipitate was analyzed to determine its composition. The ultraviolet absorption spectra were obtained. (M.C.G.)

**28837** (UCRL-Trans-958) DISSOCIATION PRESSURE OF INDIUM SULFIDE. N. A. Khvorostukhina and I. K. Skobeev. Translated by D. A. Nimidoff (California. Univ., Berkeley. Lawrence Radiation Lab.) from Tr. Vost.-Sibirsk. Filiala, Akad. Nauk SSSR, No. 41, 72-7(1962). 18p.

Data are obtained for the dissociation pressure of indium sulfide at 800 to 1020°C. The mechanism of sublimation of indium and its sulfide is determined by the dissociation pressure of $In_2S_3$ and an estimate of its thermodynamic constant. Information is given on the calculation of dissociation pressure coefficients, isobaric potential changes at dissociation, heat content changes at dissociation, and entropies at dissociation. In the temperature range studied, the dissociation pressure of $In_2S_3$ exceeds the corresponding pressures for sulfides of zinc, iron, and copper, but is markedly lower than that of lead sulfide. (N.W.R.)

**28838** OBSERVATIONS ON THE FUSION POINTS OF TWO HYDRATES OF CERIUM(III) NITRATE. Bernard Claudel (Institut de Recherches sur la Catalyse, Villeurbanne, France). Bull. Soc. Chim. France, No. 6, 1334-5 (June 1963). (In French)

The fusion point of $Ce(NO_3)_3 \cdot 4H_2O$ is found to be about 92°C. This fusion is found to be incongruent, because the melt contains less water of hydration than does the solid. It is noted that the fusion point of $Ce(NO_3)_3 \cdot 6H_2O$ is 52°C. The phase diagram of the $Ce(NO_3)_3$–$H_2O$ system is given. (T.F.H.)

**28839** THE PROBLEM OF CHEMICAL BONDS IN XENON TETRAFLUORIDE. Yigal Julius Israëli (Université Hébraique, Jerusalem). Bull. Soc. Chim. France, No. 6, 1336(June 1963). (In French)

An electron energy-level scheme is proposed to explain the chemical properties of $XeF_4$, which has the planar crystal structure $D_{4h}$. (T.F.H.)

**28840** KINETICS OF THE FLUORIDATION OF SOME COMPOUNDS OF URANIUM. Gérard Vandenbussche and Tivadar Kikindai (CEA, Fontenay-aux-Roses and École Centrale des Arts et Manufactures, [Paris]). Compt. Rend., 256: 4657-60(May 27, 1963). (In French)

The reactions between fluorine and $UO_2$, $UO_2F_2$, and $U_3O_8$ have analogous kinetics of the "interface reaction" type. (tr-auth)

**28841** THE PREPARATION OF OXALATE–SULFITE AND SULFITE COMPLEX COMPOUNDS OF THORIUM AND URANIUM(IV). A. D. Gel'man, L. N. Essen, F. A. Zakharova, D. P. Alekseeva, and M. M. Orlova (Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 149: 1071-3(Apr. 11, 1963). (In Russian)

Thorium oxalate and sodium sulfite were used as the starting materials in synthesizing the mixed complexes of thorium. The thorium oxalate was dissolved in a concentrated solution of sodium sulfite. On pouring this solution into alcohol, a heavy syrupy material separated out which was converted to a white crystalline substance on repeated treatment with alcohol. The number of sulfite groups in the isolated complex depended on the mol ratios of the initial materials, and also on the concentration of the solution. With a mol ratio of thorium oxalate to sulfite of 1:4, and with a 25 ml volume of water, the complex had the composition $Na_6[Th(C_2O_4)_2(SO_3)_3] \cdot 5\text{-}6H_2O$. With a mol ratio of 1:5, the composition of the solid was $Na_8[Th(C_2O_4)_2(SO_3)_4] \cdot 6H_2O$, and with mol ratios of 1:7 and 1:8, the compositions were $Na_{12}[Th(C_2O_4)_2(SO_3)_6] \cdot 5\text{-}6H_2O$ and $Na_{14}[Th(C_2O_4)_2(SO_3)_7]$

5-6$H_2O$ respectively. At a mol ratio of 1:6, the composition of the complex was $Na_{10}[Th(C_2O_4)_2(SO_3)_5] \cdot 5\text{-}6H_2O$. With the use of 50 ml of water (a decrease in concentration by a factor of 2), the complex contained less sulfite groups. Thus, with a mol ratio of thorium oxalate to sulfite of 1:6, the composition was $Na_8[Th(C_2O_4)_2(SO_3)_4] \cdot 5H_2O$. At mol ratios of 1:7 and 1:8, the compositions of the complexes were $Na_{10}[Th(C_2O_4)_2(SO_3)_5] \cdot 5H_2O$ and $Na_{12}[Th(C_2O_4)_2(SO_3)_6] \cdot 5H_2O$ respectively. Oxalate-sulfite complexes of U(IV) were isolated by a similar method. With an initial mol ratio of $U(C_2O_4)_2 \cdot 6H_2O$ to $Na_2SO_3$ of 1:2, the composition of the complex was $Na_2[U(C_2O_4)_2(SO_3)] \cdot 3.5H_2O$. With mol ratios of 1:3 and 1:4, the complexes were $Na_4[U(C_2O_4)_2(SO_3)_2] \cdot 2H_2O$ and $Na_6[U(C_2O_4)_2(SO_3)_3] \cdot 5H_2O$. With mol ratios of 1:5, 1:6, and 1:8, the complexes were $Na_8[U(C_2O_4)_2(SO_3)_4] \cdot 4H_2O$, $Na_{10}[U(C_2O_4)_2(SO_3)_5] \cdot 7.5H_2O$ and $Na_{12}[U(C_2O_4)_2(SO_3)_6] \cdot 7\text{-}8H_2O$ respectively. All complexes showed two oxalate groups and a variable number of sulfite groups. The complexes were adsorbed by anion exchangers. The complexes $Na_6[U(SO_3)_5] \cdot nH_2O$, $Na_8[U(SO_3)_6] \cdot nH_2O$, $Na_{10}[U(SO_3)_7] \cdot nH_2O$, and $Na_{12}[U(SO_3)_8] \cdot nH_2O$ were also prepared from $K_3H_3[U(NO_3)_{10}] \cdot 3H_2O$ and anhydrous sodium sulfite. (TTT)

**28842** AN INVESTIGATION OF THE $BeF_2$–$ZrF_4$ SYSTEM. Yu. M. Korenev and A. V. Novoselova (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 149: 1337-9(Apr. 21, 1963). (In Russian)

Calculated amounts of $(NH_4)_2BeF_4$ and $(NH_4)_3ZrF_7$ were mixed together in a nickel or platinum crucible and heated in a current of $CO_2$ to drive off the ammonium fluoride. The mixture was homogenized at 380 to 400°C for 30 hours in an argon atmosphere of 100 to 120 mm Hg std in order to suppress the volatilization of zirconium fluoride. The mixtures were subjected to x-ray and thermal analyses. A reversible $\alpha \rightleftharpoons \beta$ transformation of $ZrF_4$ was observed at 690°C. Melting of zirconium fluoride took place at 903°C. The quartz-like form of $BeF_2$ was found in mixtures homogenized at 400°C. A rhombic modification of $BeF_2$ was formed in the presence of small amounts of zirconium fluoride, but this modification was converted to the quartz-like form of $BeF_2$ after homogenizing at 400°C. Only one incongruently-melting compound having the composition $BeZrF_6$ was found in the $BeF_2$–$ZrF_4$ system. The temperature of the peritectic reaction for the formation of this compound was 712°C. The eutectic between $BeZrF_6$ and $BeF_2$ was at a temperature of 578°, and 80 mol % of $BeF_2$. A phase diagram of the $BeF_2$–$ZrF_4$ system is presented. (TTT)

**28843** THE HEAT CONDUCTIVITIES OF THE ALKALINE EARTH AND RARE EARTH HEXABORIDES. S. N. L'vov, V. F. Nemchenko, and Yu. B. Paderno (Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 149: 1371-2 (Apr. 21, 1963). (In Russian)

The thermal conductivities of the hexaborides of Ca, Sr, Ba, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Yb, and Th were measured systematically at room temperature, and were compared with the thermal conductivities and electrical conductivities of the metals. The electron contribution $\lambda_e$, and the phonon contribution $\lambda_\phi$ of the thermal conductivities of the metals and hexaborides were calculated from the equation $\lambda_\phi = \lambda - L_0\sigma T$. Here $\lambda$ is the experimental value of the thermal conductivity; $\sigma$ is the specific electrical conductivity; $L$ is the Lorentz number, and T is the absolute temperature. The thermal conductivities of the hexaborides are approximately a factor of three higher than the thermal conductivities of the metals. The relative phonon contribution to the thermal conductivities of the hexaborides is generally greater than in the metals, especially for the hexaborides of Sm, Eu, Yb, and the alkaline earth metals, in which the phonon contribution is even higher than the electronic contribution. The increased thermal conductivity is due to the presence of strong covalent bonds between the boron atoms in the hexaborides. (TTT)

**28844** LATTICE ENERGY OF ALKALINE HALIDES. S. Chatterjee (Indian Assn. for the Cultivation of Science, Calcutta). Indian J. Phys., 37: 105-10(Feb. 1963).

The lattice energy of the alkali halides was calculated by assuming the potential function in the form $\phi(r) = -(\alpha e^2/r) + (B/r^n) - (C/r^6) - (D/r^8) + \epsilon_0$ where the index n and the constant B were determined from the equilibrium conditions and the experimental data on the compressibility and the inter-ionic distance. The values of $\phi$ for the alkali halides are found to be very close to the experimental values as well as to the values calculated from the exponential form of the potential function. The values of compressibility and thermal expansion are also calculated, and the agreement with the experimental values is excellent. (auth)

**28845** REDUCTION OF $TiO_2$ AND $Nb_2O_5$ BY $CaC_2$ AND $CaCN_2$. G. A. Meerson, L. A. Yakeshova, and T. A. Shvedova. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 1, 69-75(Jan.-Feb. 1963). (In Russian)

Thermodynamic calculations and tests showed the feasibility of $TiO_2$ and $Nb_2O_5$ reduction by calcium carbide ($CaC_2$) and by calcium cyanamide ($CaCN_2$) at 1000°C. (R.V.J.)

**28846** VIBRATIONAL SPECTRA AND STRUCTURE OF XENON TETRAFLUORIDE. Howard H. Claassen, Cedric L. Chernick, and John G. Malm (Argonne National Lab., Ill). J. Am. Chem. Soc., 85: 1927-8(July 5, 1963).

The infrared spectrum of $XeF_4$ vapor has strong bands at 123, 291, and 586 $cm^{-1}$. The Raman spectrum of the solid has very intense peaks at 502 and 543 $cm^{-1}$ and weaker ones at 235 and 442 $cm^{-1}$. These data show that the molecule is planar and of symmetry $D_{4h}$. The seven fundamental frequencies were assigned as 543 ($a_{1g}$), 291 ($a_{2u}$), 235 ($b_{1g}$), 221 ($b_{1u}$), 502 ($b_{2g}$), 586 ($e_u$), and 123 ($e_u$). The ($b_{1u}$) frequency value is quite uncertain. (auth)

**28847** THE TEMPERATURE-INDEPENDENT FACTOR OF THE KINETIC ISOTOPE EFFECT. C. Gardner Swain and Richard L. Schowen (Massachusetts Inst. of Tech., Cambridge). J. Am. Chem. Soc., 85: 2023-4(July 5, 1963).

A discussion is presented for the temperature-independent factor $\nu_1^*/\nu_1^{**}$ in the equation for the kinetic isotope effect in terms of vibration frequencies of the reactants and activated complex. It is shown that if all real vibration frequencies are greater than 6kT/h, the variations in the imaginary frequency ratio with transition-state structure are precisely canceled by converse variations in the other linear-frequency ratio. Hence, the temperature-independent factor is not affected. The calculation of an isotope effect at a single temperature using an estimated temperature-dependent factor is treated. (D.L.C.)

**28848** ZIRCONIUM CARBIDE: HEAT CAPACITY AND THERMODYNAMIC PROPERTIES FROM 5 TO 350°K. Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor) and George Feick. J. Chem. Eng. Data, 8: 176-8(Apr. 1963).

The heat capacity of a characterized, zone-melted sample of ZrC was measured by adiabatic calorimetry from 5 to 350°K and found to be of normal sigmoid shape without transitions or thermal anomalies. At 298.15°K the measured heat capacity at constant pressure ($C_p$), the practical entropy ($S^\circ$), the enthalpy function ($[H^\circ - H_0^\circ]/T$), and the Gibbs function ($-[G^\circ - H_0^\circ]/T$) are 9.06, 7.96, 4.70, and 3.26 cal $(gfm°K)^{-1}$. Values of the heat capacity and entropy, adjusted to pure ZrC on the basis of the impurity content obtained by chemical analysis, are 9.13 and 7.90 cal $(gfm°K)^{-1}$. (auth)

**28849** ZIRCONIUM DIBORIDE: HEAT CAPACITY AND THERMODYNAMIC PROPERTIES FROM 5° TO 350°K. Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor) and George Feick. J. Chem. Eng. Data, 8: 193-6(Apr. 1963).

The heat capacity of a characterized, zone-melted sample of zirconium diboride was measured over the temperature range 5 to 350°K by adiabatic calorimetry and found to be of a normal sigmoid shape without transitions or thermal anomalies. Values of the heat capacity at constant pressure ($C_p$), entropy ($S°$), and Gibbs function $(-[G° - H°_0]/T)$ are 11.53, 8.59, and 3.25 cal $(gfm°K)^{-1}$, respectively, at 298.15°K. (auth)

**28850** COLLISIONAL TRANSITION PROBABILITIES FOR VIBRATIONAL DEACTIVATION OF CHEMICALLY ACTIVATED sec-BUTYL RADICALS. THE RARE GASES. G. H. Kohlmaier and B. S. Rabinovitch (Univ. of Washington, Seattle). J. Chem. Phys., 38: 1692-1708(Apr. 1, 1963).

Vibrationally excited sec-butyl radicals, having a narrow range of energies above 40 kcal $mole^{-1}$, were produced in a heat bath of cis-butene-2–rare-gas mixtures by H addition to cis-butene-2. He, Ne, Ar, and Kr were used. Two competing reactions of the chemically activated radicals, decomposition by C–C rupture with critical energy of 33 kcal $mole^{-1}$ and collisional stabilization, were studied as a function of pressure. Apparent rate constants for decomposition $k_\alpha$ were obtained at three temperatures over a range of bath pressures by analysis of the decomposition and stabilization products. Strong and weak multistep collisional deactivation processes, corresponding to transfer of all or only part of the initial excess vibration energy (≥7 kcal $mole^{-1}$) of the radicals, were considered. Multistep models of various step sizes ($\Delta E$) give a family of calculated curves of $k_\alpha$ as a function of p, each of which turns up from a quasi-constant value at higher pressures to higher values at low pressures. Comparison with the low-pressure experimental "turnup" yielded information on $\Delta E$, independent of the assumed collision cross section. Comparison of relative rates in the higher-pressure region gave minimum estimates of $\Delta E$ or, alternatively, conventional "efficiency" factors, $\beta_{min}$; these conclusions are somewhat dependent on the assumed cross section. Values of $\Delta E$ from the lower-pressure turnup data bunch at 2.5 to 3.5 kcal $mole^{-1}$ on an assumed stepladder model of transition probabilities. Such a model corresponds only formally to harmonic oscillator restrictions, and encompasses the characteristics of models in which small steps are less probable than large ones. Values of $(\Delta E)_{exp}$ for an exponential weighting of transition probabilities group at 1.2 to 1.8 kcal $mole^{-1}$; this distribution describes the characteristics of models in which small steps are more probable than large ones and seems to be the preferred description of the rare-gas behavior here. He and Ne appear to transfer less energy than Kr and Ar. $\Delta E$ for cis-butene itself was confirmed to be ≥9 kcal, as derived in a previous study of deactivation of sec-butyl-$d_1$ radicals by Harrington, Rabinovitch, and Hoare; and by contrast, the stepladder model is more appropriate here. From the higher-pressure data, values of $\beta_{min}$ which varied from 0.16 for He at 100°C to 0.62 for Kr at −78°C were found. The efficiencies increase with increasing atomic weight of the rare gas and with decreasing bath temperature. Energy transfer between rare-gas atoms and butyl radicals is thus surprisingly efficient, with relatively large amounts of energy transferred per collision ($(\Delta E) > kT$). The findings provide further detailed evidence concerning the inapplicability of the Landau–Teller theory and related models to polyatomic molecules at high vibrational energies (cf. Herzfeld and Litovitz). The possible role of rotational degrees of freedom is considered. (auth)

**28851** COLLISIONAL TRANSITION PROBABILITIES FOR VIBRATIONAL DEACTIVATION OF CHEMICALLY ACTIVATED sec-BUTYL RADICALS. DIATOMIC AND POLYATOMIC MOLECULES. G. H. Kohlmaier and B. S. Rabinovitch (Univ. of Washington, Seattle). J. Chem. Phys., 38: 1709-14(Apr. 1, 1963).

The study of collisional transitional probabilities for the de-excitation by inert gases of chemically activated sec-butyl radicals, excited to internal energies in excess of 40 kcal $mole^{-1}$, was extended to $H_2$, $D_2$, $N_2$, $CO_2$, $CH_4$, $CD_3F$, $CH_3Cl$, and $SF_6$. The diatomic gases display behavior similar to the rare gases, and on a preferred exponential model of collisional transition probabilities the average amount of energy transferred per collision is $(\Delta E)_{exp} \simeq 1.3$ kcal $mole^{-1}$. On a stepladder model the corresponding amount is $\Delta E \simeq 2.5$ kcal $mole^{-1}$. From higher-pressure data, the efficiency for $CD_3F$, $CH_3Cl$, and $SF_6$ is deduced to be comparable with that for butene and, on a preferred stepladder model, $\Delta E > 9$ kcal. For $CO_2$ and $CH_4$ the behavior is intermediate. The possible importance of the role of internal rotation of butyl in facilitating energy transfer is noted; some uncertainty concerning the role of over-all rotations and vibrational modes of the deactivator in the relaxation process exists. (auth)

**28852** THEORY OF INERT-GAS FLUORIDES. R. K. Nesbet (IBM Research Lab., San Jose, Calif.). J. Chem. Phys., 38: 1783-4(Apr. 1, 1963).

It is suggested that the principal binding mechanism in $XeF_2$ and $XeF_4$ is identical with the superexchange mechanism in antiferromagnetic oxides such as MnO. The theory is expressed in terms of localized orthonormal transforms of Hartree-Fock molecular orbitals. The case of $XeF_2$ is considered in some detail. A table of parameters and binding energies is given for linear inert-gas difluorides. It is concluded that the formalism explains the stability of $XeF_2$, and that, since stability increases with nuclear charge, $RnF_2$ should be more stable than $XeF_2$ but none of the lighter inert-gas fluorides are stable. (D.L.C.)

**28853** HEAT CONTENT OF URANIUM DICARBIDE FROM 1484° TO 2581°K. L. S. Levinson (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 38: 2105-6 (May 1, 1963). (LADC-5588)

The heat content and specific heat of $UC_{1.93}$ was measured from 1484 to 2581°K using a drop calorimeter. The heat of transformation from tetragonal to cubic structure at 2043°K was 11.0 cal/g. (D.L.C.)

**28854** SPECULATION CONCERNING THE NATURE OF BINDING IN XENON FLUORINE COMPOUNDS. Joshua Jortner, Stuart A. Rice, and E. Guy Wilson (Univ. of Chicago). J. Chem. Phys., 38: 2302-3(May 1, 1963).

A description is proposed for the bonding in $XeF_2$ in terms of delocalized molecular orbitals formed by combination of $p\sigma$-type Xe and F orbitals. The energy levels and charge distribution were evaluated, and it is concluded that (1) The bond energy per XeF bond in linear $XeF_2$ is on the order of 4 ev for an assumed bond length of 2 A. (2) The first allowed optical transition is $\psi(a_{1g}) \rightarrow \psi(a_{2u}^*)$, with a transition energy of 8.2 ev. (3) The bond energy in the XeF radical is less than the bond energy per bond in $XeF_2$. (4) The bent $XeF_2$ structure is less stable than the linear structure. (5) When the effects of $\pi$ binding are introduced, the binding energy in $XeF_2$ is at a maximum at $R_{Xe-F} \simeq$ 1.85 A. Conclusions (3), (4), and (5) are consistent with

the experimental data. It is also concluded that the migration of negative charge from Xe to F is substantial (0.5 charge unit per F atom), and indeed the behavior of $XeF_2$ is similar to that of ionic compounds. (D.L.C.)

**28855** OPTIMUM RATIO OF CATIONS ON NUCLEAR SULFONIC ACID RESIN FOR MINIMUM CHANGE IN COMPOSITION OF RESIN-TREATED MILK. Albert R. Landgrebe, L. F. Edmondson, and F. W. Douglas, Jr. (Dept. of Agriculture, Washington, D. C.). J. Dairy Sci., 46: 181-5 (Mar. 1963).

For the purpose of developing a large-scale method for removing radiostrontium from milk, preliminary studies were carried out with Amberlite IR-120. The optimum mole fraction of the major cations ($Ca^{2+}$, $K^+$, $Na^+$, and $Mg^{2+}$) on the strong sulfonic acid ion-exchange resin for minimum change in milk composition was determined by equilibrating the resin with milk at pH 5.4 and 6.6. The fraction of Ca on the resin increased with decreasing pH, whereas those of Na and K decreased. Mg was present in relatively small amounts, and it appeared to be little affected by pH. Relative affinities of ions for the resin were: Sr > Ca > Mg > K > Na. By using the milk-equilibrated mole fraction of the cations on the resin, and the apparent equilibrium constants involving the ions and the resin, mixed regenerating solutions of the chlorides of the 4 cations were prepared. The concentrations were adjusted so that the ratio of ions on the resin would be in equilibrium for milk at pH 6.6 and 5.4. Milk passed through columns of these resins showed little change in the cationic composition. The cationic composition of milk varies with breed of the animal, season of the year, and with other factors. Consequently, the milk-equilibrated mole fraction of cations placed on a resin will vary. (H.H.D.)

**28856** NUCLEAR MAGNETIC RESONANCE STUDIES IN THE SERIES $ZrF_4 \cdot xHF \cdot yH_2O$. I. THE CONSTITUTION OF THE HYDRATES OF ZIRCONIUM TETRAFLUORIDE. S. Maričić, P. Strohal, and Z. Veksli ("Rudjer Bošković" Inst., Zagreb). J. Inorg. Nucl. Chem., 25: 789-94 (July 1963). (In English)

Proton and fluorine magnetic resonance spectra prove that the hydrates of zirconium tetrafluoride are correctly formulated as $ZrF_4 \cdot H_2O$ and $ZrF_4 \cdot 3H_2O$. The results are related to the possible crystal structure of the trihydrate. It is found that 10 to 20 per cent surplus water is unavoidably incorporated into the crystal lattice of the monohydrate prepared by the usual methods, but pure monohydrate could be obtained by dehydrating $ZrF_4 \cdot 3H_2O$ at 110°C. (auth)

**28857** PREPARATION AND PROPERTIES OF SOME URANIUM SELENIDES AND TELLURIDES. L. K. Matson, J. W. Moody, and R. C. Himes (Battelle Memorial Inst., Columbus, Ohio). J. Inorg. Nucl. Chem., 25: 795-800 (July 1963). (In English)

Selenides and tellurides of uranium were prepared by solid-vapor reaction and densified by melting. Melting points were estimated, and some structures were determined by x-ray analysis. Electric resistivities, Hall coefficients, and thermoelectric powers of specimens of compounds were measured. The electric properties indicate, generally, that these compounds are semimetallic conductors. (auth)

**28858** COMPLEXES OF THE RARE EARTHS. V. PIPERIDINE-2,6-DICARBOXYLIC ACID. L. C. Thompson (Univ. of Minnesota, Duluth). J. Inorg. Nucl. Chem., 25: 819-22 (July 1963). (In English)

Step-wise formation constants were determined for the rare earths (including yttrium) with piperdine-2,6-dicarboxylic acid. The measurements were made in aqueous solutions of ionic strength $\mu = 0.1$ ($KNO_3$) and a temperature of 25°C. The data were interpreted in terms of 1:1 and 2:1 chelates. Trends in the values of log $K_1$ and log $K_2$ are discussed and compared with similar values for other ligands which contain the same basic chelating structure. It is shown that the size of the metal ion is an important factor in determining the magnitude of the formation constants of piperidine-2,6-dicarboxylic acid chelates in much the same way as in the chelates of dipicolinic acid. (auth)

**28859** PYROLYSIS OF URANIUM COMPOUNDS. I. URANYL SULPHATE. K. J. Notz and H. H. Jaffe (Univ. of Cincinnati). J. Inorg. Nucl. Chem., 25: 851-7 (July 1963). (In English)

The pyrolysis of $UO_2SO_4 \cdot 3H_2O$ was studied by means of differential thermal analysis (DTA) and thermogravimetric analysis (TGA). Dehydration occurred in three steps, with the consecutive formation of the dihydrate, the monohydrate, and finally the anhydrous salt. At 755°, $UO_2SO_4$ undergoes an enantiotropic phase transition. The rate of decomposition of $UO_2SO_4$ to $U_3O_8$ was deduced to be limited by both nucleation and growth. The rate expression for this reaction, in terms of milligrams of weight lost per minute per square meter of active surface is: rate = $11 \times 10^{14} \exp(-58,600/RT)$. (auth)

**28860** THE ANION EXCHANGE OF METAL COMPLEXES. XII. THE CADMIUM AND MERCURY-HALIDE SYSTEMS. Y. Marcus and I. Eliezer (Israel Atomic Energy Commission, Rehovoth). J. Inorg. Nucl. Chem., 25: 867-74 (July 1963). (IA-794) (In English)

The distribution of trace cadmium and mercury ions between Dowex-1 strong-base anion exchanger, and solutions of hydrochloric acid, lithium chloride and bromide, and sodium chloride, bromide, and iodide was measured. Resin ligand activity functions for these electrolyte-resin systems were obtained and used to show that the predominant complex species in both solution and resin, over the halide concentration range one M to saturation, is the tetrahalide. Only in hydrochloric acid (but not in hydrobromic acid) is there evidence for other species, which may be the undissociated acids, as suggested in the literature. The results for the other electrolytes indicate the validity of the effective ligand activity concept also in bromide and iodide solutions. (auth)

**28861** HAFNYL TRIPHOSPHATES. E. Giesbrecht, G. Vicentini, and M. Perrier (Universidade de São Paulo, Brazil). J. Inorg. Nucl. Chem., 25: 893-6 (July 1963). (In English)

The reactions of hafnium and hafnyl compounds with sodium triphosphate were investigated and the following products isolated: $(HfO)_5(P_3O_{10})_3 \cdot 2Na_5P_3O_{10} \cdot 12H_2O$, $(HfO)_2NaP_3O_{10} \cdot 4H_2O$, and $(HfO)_5(P_3O_{10})_2 \cdot 12H_2O$. The potentiometric and conductometric behavior of these compounds were studied and found to be similar to these of zirconium and zirconyl triphosphates. (D.L.C.)

**28862** THE POLYALKALINE EARTH URANATES $Sr_2UO_5$ AND $Ca_2UO_5$. J. O. Sawyer (Univ. of Melbourne). J. Inorg. Nucl. Chem., 25: 899-902 (July 1963). (In English)

The calcium and strontium compounds were prepared by the solid state reactions: $CaUO_4 + Ca_3UO_6 \rightarrow Ca_2UO_5$ at 975°C in air, and $SrUO_4 + Sr_3UO_6 \rightarrow Sr_2UO_5$ at 1000°C in air. The structures of $Ca_2UO_5$ and $Sr_2UO_5$ were studied in some detail, and the structural parameters are given. (D.L.C.)

**28863** THE PRESSURE DEPENDENCE OF THE LINEAR OXIDATION OF NIOBIUM IN THE TEMPERATURE RANGE 450°–1050°C. C. H. McLintock and J. Stringer (Univ. of Liverpool). J. Less-Common Metals, 5: 278-94 (June 1963).

The pressure dependence of the linear oxidation of niobium was studied using both constant-pressure and varying-pressure techniques in the temperature range 450 to 1050°C, for pressures in the range 10 to 760 mm Hg of oxygen. Below 600°C there is an initial slow linear rate during which a continuous oxide layer forms. After a time, a powdery oxide nucleates on the metal surface bursting through the continuous layer and the reaction accelerates to a faster linear rate. The breakaway time is very variable, but decreases as the temperature is raised, and above 560°C is too short to be detectable. The pre-breakaway rate is shown to involve an equilibrium adsorption step, with a low-pressure rate depending on the square root of the pressure. The post-breakaway rate depends on pressure to the power 0.7 to 0.8, and the activation energy of this step is about 17 kcal mole$^{-1}$. In the range 600 to 650°C the shape of the rate curves changes, the overall rate diminishing. This decrease is shown to be due to a third linear rate appearing at increasingly early times in this range, with a rate depending on the square root of the oxygen pressure and an associated activation energy of 28.0 kcal mole$^{-1}$. Above 850°C a fourth linear rate appears, depending on pressure to the power 0.7 to 0.9. The pressure dependence increases linearly with temperature. The temperature dependence of the overall reaction is small and is a function of pressure. The inapplicability of the Arrhenius equation to this process is demonstrated. (auth)

**28864** SOME STUDIES OF THE OXIDATION OF URANIUM DIOXIDE. K. T. Scott and K. T. Harrison (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 8: 307-19(May 1963). (AERE-R-4120). (In English)

The use of a new automatically recording microbalance and its application to thermogravimetry are described. This technique is applied to the investigation of the oxidation of various uranium dioxide preparations in air at temperatures up to 800°C. Under conditions of linearly increasing temperature, fine uranium dioxide powders are shown to oxidise in a characteristic two-step process first to a tetragonal phase of composition $UO_{2.35\pm0.02}$ and then to $U_3O_8$. An activation energy of 19.1 kcal is derived for the $UO_2 \rightarrow$ "$U_3O_7$" oxidation. Uranium dioxide of low surface area exhibits only a single stage oxidation from $UO_2 \rightarrow U_3O_8$. Initiation of reactions and oxidation rates are found to be proportional to the heating rate. (auth)

**28865** PHYSICAL SYSTEM OF ELEMENTS. C. G. Bedreag (Univ. of Iasi, Rumania). J. Phys., 24: 27-32 (Jan. 1963). (In French)

After a short historical account of the evolution of the periodic system, properties of various groups of elements: density, spectra, ionic radii, ionization potentials, and so on are analyzed. Arguments are given in favor of the division of the transuranic elements to uranides and curides. (auth)

**28866** VISIBLE SPECTRUM OF XeN. L. Herman and R. Herman. J. Phys., 24: 73-5(Jan. 1963). (In French)

The results of an incomplete analysis of the rotation structure of a band system of XeN between 4920 and 4750 Å are reported. The approximate wave lengths of the intensity maxima are tabulated. Two series of rays whose separation increases toward the short wave lengths are detected. The spectroscopic results obtained on the chemical nature of this type of unstable molecule are compared with those deduced from the interaction between the atoms under the effect of the mutual polarization. (J.S.R.)

**28867** HYDROLYTIC TENDENCIES OF FERRIC CHELATES. Richard L. Gustafson and Arthur E. Martell (Clark Univ., Worcester, Mass. and Illinois Inst. of Tech., Chicago). J. Phys. Chem., 67: 576-82(Mar. 1963).

Potentiometric equilibrium measurements are reported for the hydrolysis and polymerization of Fe(III) complexes of ethylenediaminetetraacetic acid (EDTA), cyclohexanediaminetetraacetic acid (CDTA), N-hydroxyethylethylenediaminetriacetic acid (HEDTA), and nitrilotriacetic acid (NTA), which have a 1:1 molar ratio of ligand to metal ion. Equilibrium constants are reported for the formation of monohydroxo mononuclear complexes, and for their conversion to $\mu$-dihydroxo binuclear chelates. Heats and entropies of reaction for the formation of EDTA and CDTA mono- and binuclear dihydroxo species were calculated from temperature coefficient data. The results are interpreted on the basis of the probable structures of the metal complexes formed. (auth)

**28868** THE SECOND DISSOCIATION CONSTANT OF DEUTERIOSULFURIC ACID FROM 25 TO 225°. M. H. Lietzke and R. W. Stoughton (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 652-4(Mar. 1963).

The second dissociation constant of deuteriosulfuric acid was computed from 25 to 225° from data on the solubility of $Ag_2SO_4$ in $D_2SO_4$ solutions. In addition, the thermodynamic constants for the reaction $DSO_4^- = D^+ + SO_4^{-2}$ are presented. A comparison with the corresponding values for the $H_2SO_4$ system is given. (auth)

**28869** THERMOCHEMISTRY OF ANION MIXTURES IN SIMPLE FUSED SALT SYSTEMS. I. SOLUTIONS OF MONOVALENT CHLORIDES AND BROMIDES IN THE CORRESPONDING NITRATES. O. J. Kleppa and S. V. Meschel (Univ. of Chicago). J. Phys. Chem., 67: 668-71(Mar. 1963).

Calorimetric measurements were performed on the heats of solution and of dilution for monovalent chlorides and bromides dissolved in the corresponding liquid nitrates. It is found that all the studied alkali halide–alkali nitrate systems exhibit small positive enthalpies of mixing, with the largest effects observed for the sodium systems. It is suggested that these results may be explained in terms of a packing effect which is due to the repulsion between the second nearest neighbor anion cores. Corresponding data for the silver and thallium salts are more complex. They cannot be explained in terms of the second nearest neighbor interactions. (auth)

**28870** THE HEATS OF FUSION AND TRANSITION OF ALKALINE EARTH AND RARE EARTH METAL HALIDES. A. S. Dworkin and M. A. Bredig (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 697-8(Mar. 1963).

The heats of fusion of fifteen rare earth and alkaline earth halides were measured by means of a copper block drop calorimeter. The salts and their heats of fusion in kcal mole$^{-1}$ are $LaCl_3$, 13.0; $PrCl_3$, 12.1; $NdCl_3$, 12.0; $CeI_3$, 12.4; $PrI_3$, 12.7; $NdI_3$, 9.7; $CaCl_2$, 6.78; $CaBr_2$, 8.95; $CaI_2$, 10.0; $SrCl_2$, 3.88; $SrBr_2$, 2.50; $SrI_2$, 4.70; $BaCl_2$, 3.90; $BaBr_2$, 7.63; and $BaI_2$, 6.34. The four salts which showed a transition, their temperatures of transition in °K and their heats of transition in kcal mole$^{-1}$ are $NdI_3$, 847, 3.4; $SrCl_2$, 1003, 1.65; $SrBr_2$, 918, 2.90; and $BaCl_2$, 1193, 4.10. The high temperature forms of $SrBr_2$ and $BaCl_2$ are believed to have the fluorite type of structure characterized similarly as in $CaF_2$ and $SrCl_2$ by an unusually low entropy of fusion, probably because a high degree of disorder occurs in that structure at elevated temperatures. (auth)

**28871** THE THERMODYNAMIC AND PHYSICAL PROPERTIES OF BERYLLIUM COMPOUNDS. II. HEAT OF FORMATION AND ENTROPY OF BERYLLIUM(II) FLUORIDE. Michael A. Greenbaum, R. E. Yates, M. Louis Arin, Mohammed Arshadi, Justine Weiher, and Milton Farber (Rocket Power, Inc., Pasadena Calif.). J. Phys. Chem., 67: 703-9(Mar. 1963).

The molecular flow effusion method was employed to obtain second and third law heats of formation of BeF(g) from a study of the reaction $BeF_2(g) + Be(s,l) = 2BeF(g)$ over the temperature range 1425 to 1675°K. The $\Delta H$ of reaction was found to be 91.5 ± 3.8 kcal/mole, while the corresponding entropy of reaction was found to be 44.3 ± 2.4 cal/deg/mole. Employing recent experimental data together with available thermal functions for the constituents, a value of −48.3 ± 1.9 kcal/mole is obtained for $\Delta H_{f298}$ BeF(g) and 51.1 ± 1.2 cal/deg/mole for the $S_{298}$ BeF. The third law value for $\Delta H_{f298}$ of BeF(g) was found to be −52.6 ± 0.6 kcal/mole. (auth)

**28872** RELATIVE MOBILITIES OF LIKE-CHARGED IONS IN FUSED SALTS. Richard W. Laity and Cornelius T. Moynihan (Princeton Univ., N. J.). J. Phys. Chem., 67: 723-4(Mar. 1963).

Hittorf-type transference experiments on the molten system LiCl–KCl are reported. In spite of the varying cation mobilities, they were found to be similar at all concentrations. The literature was reviewed for all data on relative mobilities of like-charged ions in binary fused salt mixtures. Some of the systems reviewed are LiCl–KCl, $AgNO_3$–$NaNO_3$, $AgNO_3$–AgCl, $PbCl_2$–KCl, etc. The data are generally consistent with the hypothesis that the mobilities of like-charged ions are equal within 10 to 15% at all concentrations. (D.L.C.)

**28873** A THERMODYNAMIC STUDY OF THE THORIUM–OXYGEN SYSTEM AT HIGH TEMPERATURES. R. J. Ackermann (Argonne National Lab., Ill.), E. G. Rauh, R. J. Thorn, and M. C. Cannon. J. Phys. Chem., 67: 762-9(Apr. 1963). (TID-17092; UAC-6710)

The evaporation behavior of the thorium–oxygen system in the temperature range 2000 to 3000°K was studied. The results of the effusion measurements of the dioxide phase and liquid metal–dioxide mixtures and a mass spectrometric investigation of the former were combined to yield an internally consistent set of thermodynamic data for the system. The solid dioxide evaporates congruently at all temperatures. Above 2800°K there is a measurable but thermodynamically insignificant substoichiometry, $ThO_{1.998}$. The "effective" pressure based on the assumption that the vapor is comprised entirely of dioxide molecules is given by the equation $\log p_e$ (atm.) = (8.26 ± 0.13) − (43.55 ± 0.03)$10^4/T$. The average heat and entropy of sublimation of the solid dioxide to $ThO_2(g)$ are 158.7 ± 2.5 kcal $mole^{-1}$ and 35.3 ± 1.0 e.u., respectively, and the respective values for the reaction $ThO_2(s) = ThO(g) + O(g)$ are 347.0 ± 3.1 kcal $mole^{-1}$ and 76.9 ± 1.4 e.u. The standard free energies of formation of the gaseous thorium oxides are $\Delta F_f^\circ\ ThO_2) = -138{,}600 + 11.4T$ (2000 to 3000°K) and $\Delta F_f^\circ(ThO) = -10{,}300 - 14.4T$ (2000 to 3000°K). Upper limits to the dissociation energies at absolute zero of $ThO_2(g)$ and ThO(g) are $D_0(ThO_2) \leq 16.3$ ev and $D_0(ThO) \leq 8.3$ ev. The reaction occurring in thoriated tungsten filaments is discussed. (auth)

**28874** THE SOLUBILITY OF CORUNDUM IN BASIC HYDROTHERMAL SOLVENTS. R. L. Barns, R. A. Laudise, and R. M. Shields (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Phys. Chem., 67: 835-9(Apr. 1963).

The solubility of corundum was measured in sodium hydroxide and in sodium carbonate solutions from about 400 to 600° at pressures up to about 2800 bars. In sodium hydroxide, the solubility was independent of pressure but dependent almost linearly on base concentration up to 10 m NaOH. In sodium carbonate, the solubility depended almost linearly on pressure up to about 1370 bars beyond which it was almost independent of pressure. The solubility in $Na_2CO_3$ depended almost linearly on base concentration up to 4.3 m beyond which it was independent of base. The temperature coefficient of solubility was large in $Na_2CO_3$ and nearly zero in NaOH. The solubility in LiOH, KOH, CsOH, $K_2CO_3$, $Cs_2CO_3$, and several other mineralizers is reported. The solubility data suggest that in $(OH)^-$ the predominant species is $(AlO_2)^-$ or $(AlO_3)^{2-}$ while several species are present in $(CO_3)^{2-}$. (auth)

**28875** ON THE THEORY OF OXIDATION-REDUCTION REACTIONS INVOLVING ELECTRON TRANSFER. V. COMPARISON AND PROPERTIES OF ELECTROCHEMICAL AND CHEMICAL RATE CONSTANTS. R. A. Marcus (Brookhaven National Lab., Upton, N. Y. and Polytechnic Inst., Brooklyn). J. Phys. Chem., 67: 853-7(Apr. 1963). (BNL-6422)

Using a theory of electron transfers which takes cognizance of reorganization of the medium outside the inner coördination shell and of changes of bond lengths inside it, relations between electrochemical and related chemical rate constants are deduced and compared with the experimental data. A correlation is found, without the use of arbitrary parameters. Effects of weak complexes with added electrolytes are included under specified conditions. The deductions offer a way of coördinating a variety of data in the two fields, internally as well as with each other, and a way of predicting results in one field from those in another. For example, the rate of oxidation or reduction of a series of related reactants by one reagent is correlated with that of another and with that of the corresponding electrochemical oxidation-reduction reaction, under certain specified conditions. These correlations may also provide a test for distinguishing an electron from an atom transfer mechanism. (auth)

**28876** A DEUTERIUM ISOTOPE EFFECT ON THE EXCESS ENTHALPY OF METHANOL–WATER SOLUTIONS. L. Benjamin and G. C. Benson (National Research Council, Ottawa). J. Phys. Chem., 67: 858-61(Apr. 1963).

Heats of mixing of methanol and water and of methanol-d and heavy water were determined at 25° in an adiabatic calorimeter. Deviations between the two systems are most pronounced for solutions dilute in alcohol and a Tian–Calvet microcalorimeter was used for additional measurements in this region. The results are consistent with the concept of the strengthening of hydrogen bonding by deuterium substitution. (auth)

**28877** THE INVESTIGATION OF THE KINETICS OF MODERATELY RAPID ELECTRODE REACTIONS USING ROTATING DISK ELECTRODES. Z. Galus and Ralph N. Adams (Univ. of Kansas, Lawrence). J. Phys. Chem., 67: 866-71(Apr. 1963).

The capabilities and limitations of rotated disk electrodes for the measurement of heterogeneous rate constants ($k_s$) were examined in detail. Values of $k_s$ for the oxidation–reduction systems Fe(III)–Fe(II), $Fe(CN)_6^{3-}$–$Fe(CN)_6^{4-}$, $MnO_4^-$–$MnO_4^{2-}$, and Ce(IV)–Ce(III) were determined at platinum and carbon paste rotated disks as a function of solution environment. The results for moderately rapid charge transfer rates are in good agreement with existing

data. Further correlations of $k_s$ and the homogeneous exchange rate are possible via recent theoretical interpretations of Marcus. (auth)

**28878** INFRARED SPECTRA BY MATRIX ISOLATION OF LITHIUM FLUORIDE, LITHIUM CHLORIDE, AND SODIUM FLUORIDE. Alan Snelson and Kenneth S. Pitzer (Univ. of California, Berkeley). J. Phys. Chem., 67: 982-8(Apr. 1963).

The matrix isolation method, which was adapted for infrared spectroscopy of molecular species existing at high temperatures by Linevsky, was employed to examine the spectra of LiF, LiCl, and NaF. Rather complex spectra were found. Most of the features of these spectra must arise from polymeric alkali halide species. Spectra were taken for Ar, Kr, and Xe matrices and the effects of matrix material are considered. Isotope effects as well as spectral shifts after matrix diffusion assist in the interpretation of these data. (auth)

**28879** DETERMINATION OF THE SEPARATION FACTOR FOR THE VAPORIZATION OF MIXTURES OF PROTIUM AND TRITIUM OXIDES. Hilton A. Smith and Karl R. Fitch (Univ. of Tennessee, Knoxville). J. Phys. Chem., 67: 920-1(Apr. 1963).

Results are reported for separation factor determinations using a transpiration apparatus and radiochemical analyses of the equilibrium phases. The average separation factor $\alpha$ was determined to be 1.113 at 20.0°C, 1.096 at 30.0°C, 1.076 at 40.0°C, 1.064 at 50.0°C, and 1.052 at 60.0°C. These values are in reasonable agreement with the values calculated from the equation $\alpha = \sqrt{(P^0_{H_2O}/P^0_{T_2O})}$. (D.L.C.)

**28880** GASEOUS FLUORIDES OF XENON. Martin H. Studier and Eric N. Sloth (Argonne National Lab., Ill.). J. Phys. Chem., 67: 925-6(Apr. 1963). (TID-17494; UAC-6908)

Mass spectrometric analyses were carried out on the ions produced by electron bombardment of the vapors from solid $XeF_4$. The following ions were identified: $Xe^+$, $XeF^+$, $XeF_2^+$, $XeF_3^+$, $XeF_4^+$, $Xe^{2+}$, $XeF^{2+}$, $XeF_2^{2+}$, $XeF_3^{2+}$, $XeO^+$, $XeOF^+$, $XeOF_2^+$, $XeOF_3^+$, and $XeOF_4^+$. The ions $XeF_2^+$, $XeF_4^+$, $XeOF_3^+$, and $XeOF_4^+$ probably arise from independent neutral species while the others are fragmentation products. It is concluded that $XeF_2$ exists as an independent species of greater volatility than $XeF_4$. The possible existence of $XeOF_3$ and $XeOF_4$ is discussed. (D.L.C.)

**28881** DIFFUSION OF TRITIATED WATER ($H^3H^1O^{16}$) IN AGAR GEL AND WATER. F. S. Nakayama and R. D. Jackson (Water Conservation Lab., Tempe, Ariz.). J. Phys. Chem., 67: 932-3(Apr. 1963).

The diffusion coefficient of $H^3H^1O^{16}$ at 25°C was measured at four low agar gel concentrations and the coefficient in liquid water obtained by extrapolating to zero gel concentration. The resulting value is $D = 2.41 \pm 0.055 \times 10^{-5}$ $cm^2\ sec^{-1}$, which agrees with the value of Wang et al. (D.L.C.)

**28882** THERMODYNAMICS OF SILVER BROMATE SOLUBILITY IN PROTIUM AND DEUTERIUM OXIDES. Richard W. Ramette and Edward A. Dratz (Carleton Coll., Northfield, Minn.). J. Phys. Chem., 67: 940-2(Apr. 1963).

The solubilities of $AgBrO_3$ in $H_2O$ and $D_2O$ were determined at 14.7, 25.0, and 35.0°C, using $LiClO_4$ to vary the ionic strength. The Debye-Hückel equation was used for the activity coefficient in the solubility product equation. The following thermodynamic functions for $AgBrO_3$ solubility in $H_2O$ and $D_2O$, respectively, at 25°C were calculated: $\Delta F^\circ = 5.83$ and 6.02 kcal/mole, $\Delta H^\circ = 11.7$ and 12.5 kcal/mole, and $\Delta S^\circ = 19.7$ and 21.8 cal/deg-mole. It is shown that the lower solubility in $D_2O$ is due to a larger enthalpy effect and hydration energy in $D_2O$. The entropy of crystalline $AgBrO_3$ is calculated to be $36.3 \pm 1.5$. (D.L.C.)

**28883** THERMODYNAMICS OF COPPER(II) IODATE SOLUBILITY IN PROTIUM AND DEUTERIUM OXIDES. Richard W. Ramette and Robert F. Broman (Carleton Coll., Northfield, Minn.). J. Phys. Chem., 67: 942-4(Apr. 1963).

The solubilities of $Cu(IO_3)_2 \cdot H_2O$ in $H_2O$ and of $Cu(IO_3)_2 \cdot D_2O$ in $D_2O$ were measured at 14.7, 25.0, and 35.0°C, using $LiClO_4$ to vary the ionic strength. The solubility in $D_2O$ was found to be less than that in $H_2O$. The thermodynamic functions for the respective solubilities in $H_2O$ and $D_2O$ at 25°C were calculated to be: $\Delta F^\circ = 9.73$ and 10.25 kcal/mole, $\Delta H^\circ = 6.77$ and 7.00 kcal/mole, and $\Delta S^\circ = -9.9$ and 10.9 cal/deg-mole. It is seen that the lower solubility in $D_2O$ can be attributed to unfavorable entropy and enthalpy effects. The entropy of $Cu(IO_3)_2 \cdot H_2O$ is calculated to be $39.4 \pm 2$ cal/deg-mole. (D.L.C.)

**28884** ELECTROLYTE EFFECTS ON SILVER BROMATE SOLUBILITY IN PROTIUM AND DEUTERIUM OXIDE SOLUTION AT 25°. EVIDENCE FOR ASSOCIATION OF SILVER AND NITRATE IONS. Richard W. Ramette and John B. Spencer (Carleton Coll., Northfield, Minn.). J. Phys. Chem., 67: 944-9(Apr. 1963).

The electrolyte effects of $HClO_4$, $LiClO_4$, and $LiNO_3$ on the $AgBrO_3$ solubility of $H_2O$ and $D_2O$ were studied. It was found that $HClO_4$ and $LiClO_4$ have small or no effects, while $LiNO_3$ had relatively large effects. Association quotients were calculated for $LiBrO_3$ (0.17 and 0.15 at ionic strengths 0.15 and 0.20) and for $AgNO_3$ (varies from 0.62 to 0.55 with ionic strength). (D.L.C.)

**28885** ION EXCLUSION AND SALT FILTERING WITH POROUS ION-EXCHANGE MATERIALS. Lawrence Dresner and Kurt A. Kraus (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 990-6(May 1963).

A theoretical analysis is given of the salt filtering properties of microporous bodies composed of particles with ion exchange active surfaces. The computations are based on solutions of the Poisson–Boltzmann equation for uniformly charged cylindrical micropores and for a regular lattice of charged rods; point charges are assumed for the interstitial solution. The results are discussed in terms of anticipated salt rejection as a function of effective pore radius. (auth)

**28886** THE THORIUM SULFATE COMPLEXES FROM DI-n-DECYLAMINE SULFATE EXTRACTION EQUILIBRIA. Kenneth A. Allen and W. J. McDowell (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 1138-40(May 1963).

A general method is described for obtaining aqueous complex formation constants from solvent extraction equilibria. The method involves experimentally controlled constancy of the chemical potentials in the aqueous phase, constant composition of the equilibrium organic phase being used as the criterion. A single-parameter Debye–Hückel equation with an arbitrarily fixed distance term is used as an analytic model for the ionic interactions of the aqueous species. At constant sulfuric acid activity, constant extractant concentration, and constant organic thorium molarity the distribution of thorium between di-n-decylamine sulfate in benzene and aqueous phases of varying sulfate ion concentrations is shown to lead to the following values of the hitherto-unreported formation constants of the thorium tri- and tetra-sulfate complexes, at zero ionic strength, $K_{23} = [Th(SO_4)_3^{-2}]/[Th(SO_4)_2][SO_4^{-2}] = 5.7 \pm 1.2$ and $K_{24} = [Th(SO_4)_4^{-4}]/[Th(SO_4)_3^{-2}][SO_4^{-2}] = 0.009 \pm 0.003$. (auth)

**28887** MOLAR ENTHALPIES OF MIXING IN THE MOLTEN LITHIUM FLUORIDE–POTASSIUM FLUORIDE SYSTEM. Robert A. Gilbert (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 1143-5(May 1963).

A new method for the determination of enthalpies of mixing of high melting fused salt systems is presented. The enthalpies of mixing in the molten LiF–KF system were measured at 875° with an experimental error of approximately 1%. The data may be represented by the following relationship between the molar integral enthalpy of mixing and the mole fraction of LiF(X) $\Delta H^M = X(1-X)[-3878 - 1051X - 1521X(1-X)]$. (auth)

**28888** THE ELECTRICAL CONDUCTIVITY OF SOLUTIONS OF METALS IN THEIR MOLTEN HALIDES. VI. LANTHANUM, CERIUM, PRASEODYMIUM, AND NEODYMIUM IN THEIR MOLTEN IODIDES. A. S. Dworkin, R. A. Sallach, H. R. Bronstein, M. A. Bredig, and J. D. Corbett (Oak Ridge National Lab., Tenn. and Ames Lab., Ames, Iowa). J. Phys. Chem., 67: 1145-8(May 1963).

The electrical conductivities of solutions of the series La, Ce, Pr, and Nd in their molten triiodides are similar to those of the corresponding chloride systems, and thus likewise reflect the gradual increase in stability of the dipositive ion $M^{2+}$. For example, in solutions containing 15 mole % metal, the specific electronic contribution $\kappa_{soln} - \kappa_{salt}$ decreases from 22 and 25 $ohm^{-1}\ cm^{-1}$ for La and Ce, respectively, to 4 for Pr and ~0 for Nd. The positive temperature dependence of the conductivity in the concentration range where electronic contribution is sizable indicates that there is thermal excitation of electrons from the solute. The phase equilibrium diagrams near the $MI_3$ and $MI_2$ compositions are discussed in terms of the solute species. The $MI_3$ liquidus data are compatible with the postulated $M^{2+}$ solute or its dissociation into $M^{3+}$ and anion-like electrons. The metallic character of the molten diiodides, which are metal-like $(M^{3+}(I^-)_2e^-)$ in the solid state, appears to decrease in the melt in the order La > Ce > Pr. (auth)

**28889** SOME EFFECTS OF CHARGE-COMPENSATING IONS ON CATION SITE REFERENCES IN COMPLEX OXIDES. M. Robbins, S. Lerner, and E. Banks (Polytechnic Inst., Brooklyn). J. Phys. Chem. Solids, 24: 759-69(June 1963). (In English)

The influence of anion charge compensation on the site preferences of $Ni^{2+}$ and $Co^{2+}$ in oxides such as spinels and magneto-plumbites is compared with that of cation charge compensation. By means of diffuse reflectance measurements on $Co^{2+}$ and $Ni^{2+}$-substituted $BaAl_{12}O_{19}$ and $BaGa_{12}O_{19}$, it is concluded that the use of fluoride ions as a charge compensator confers additional stability to bivalent ions in tetrahedral sites. Magnetization data on $BaCo_xFe_{12-x}O_{19-x}F_x$ and $Cu_{1+x}Fe_{2-x}O_{2-x}F_x$ are in accord with this hypothesis. Spectroscopic investigation of $Ni^{2+}$ and $Co^{2+}$ substitution in the garnets $Y_3Al_5O_{12}$ and $Y_3Ga_5O_{12}$ do not show stabilization of the tetrahedral sites, but indicate that some of the bivalent ions appear to have entered yttrium (dodecahedral) sites. (auth)

**28890** SOME CONSEQUENCES OF STRONG SPIN-LATTICE INTERACTIONS. F. Persico, K. W. H. Stevens, and J. W. Tucker (Univ. of Nottingham, Eng.). Phys. Letters, 5: 16-17(June 1, 1963). (In English)

Methods for confirming anomalous propagation in paramagnetic materials due to spin-lattice interactions are considered. Studies show that both the specific heat and the susceptibility of certain paramagnetics are altered by the strength of spin-lattice interactions. Effects of spin systems on heat conductivity are noted also to offer means of establishing anomalous propagation without using complex microwave ultrasonics experiments. (D.C.W.)

**28891** MAGNETIC STRUCTURE OF $MnYO_3$. E. F. Bertaut and M. Mercier (Centre d'Etudes Nucléaires, Grenoble, France). Phys. Letters, 5: 27-9(June 1, 1963). (In French)

The magnetic configuration due to the ordering of $Mn^{3+}$ ions at 4.2°K in the hexagon form of $MnYO_3$ is studied. Two models for the spin configuration are discussed, and calculated magnetic intensities are shown to agree with the models, presenting an ambiguity. Calculated nuclear intensities are also noted to agree well with the neutron diffraction spectrum for $MnYO_3$. (D.C.W.)

**28892** SrH AND SrD BANDS AT 2927 Å AND 2928 Å. M. Aslam Khan (Univ. of Chicago). Proc. Phys. Soc. (London), 81: 1047-52(June 1, 1963).

Details of the construction of a discharge tube, useful in both emission and absorption, are given. Two new bands of SrH at 3290 and 2927 Å (P head) and a SrD band at 2928 Å (P head) were observed in absorption. Rotational analysis of the band at 2927 Å leads to its assignment as the (0,0) band of a transition that may be called $F^2\Sigma \rightarrow X^2\Sigma$. The rotational constants were calculated. (auth)

**28893** SORPTION OF URANIUM ON ACTIVATED CARBON AND SILICA GEL IMPREGNATED WITH AMINES. Karol Akerman, Zdzislaw Kozak, and Danuta Wiater. Przemysl Chem., 42: 26-8(Jan. 1963). (In Polish)

Experiments were carried out on uranium sorption from sulfate solutions by using Carbopol H extra activated carbon and silica gel impregnated with amines. The carbon was impregnated by wetting with a solution of amines in $CCl_4$ and evaporating the solvent. Impregnation with amines caused ca. 1.5 times increase of uranium sorption in comparison with adsorption on the activated carbon alone. The impregnation of silica gel with amines was carried out by three different methods. Considerable amounts of uranium (136.6 mg/g) were adsorbed on a sorbent prepared by adsorption of amine from toluene solution, when toluene had not been completely removed after adsorption. (auth)

**28894** PREPARATION AND INVESTIGATION OF SOME PERTECHNETATES OF THE TYPE $Me^1TcO_4$. C. Keller and B. Kanellakopulos (Technische Hochschule, Karlsruhe, Ger. and Kernreaktor Bau- und Betriebs-GmbH, Karlsruhe, Ger.). Radiochim. Acta, 1: 107-8 (Jan. 1963). (In German)

Several pertechnetates were prepared. $RbTcO_4$, $CsTcO_4$, $AgTcO_4$, and $TlTcO_4$ were obtained by precipitation of $HTcO_4$ with the corresponding carbonates or nitrates, while $LiTcO_4$, $NaTcO_4$, $KTcO_4$, and $NH_4TcO_4$ were obtained by neutralization of $HTcO_4$ with the corresponding base and evaporation of the resulting solution. Technetium was determined spectrophotometrically in all compounds. Crystal structure was studied and lattice constants are given. Solubilities in water at 15 to 40°C are listed. (M.C.G.)

**28895** THE THERMAL AND GAMMA INDUCED PHOSPHORUS EXCHANGE BETWEEN PHOSPHORUS AND PHOSPHORUS TRICHLORIDE. D. Perner and A. Henglein (Hahn-Meitner-Institut für Kernforschung, Berlin). Radiochim. Acta, 1: 62-5(Jan. 1963). (In German)

The thermal exchange of P atoms between white phosphorus tagged by $P^{32}$ and phosphorus trichloride was observed at temperatures above 230°C. The activation energy and frequency factor were found to be equal to 26.3 kcal/mole and $2.76 \times 10^5\ sec^{-1}$, respectively. Red

phosphorus was simultaneously formed at a rate which was 10 times lower than that of the exchange reaction. The γ-induced reaction occurred with G (exchange) = 1.1 and G (red phosphorus) = 12 at room temperature. Larger yields were found at higher temperatures. For instance, G (exchange) amounted to 25 atms/100 ev at 192°C. G (red phosphorus) increased up to a maximum value of 40 atoms/100 ev at 160°C. These high G-values indicated a chain reaction at high temperatures. A mechanism is proposed in which partly chlorinated phosphorus rings are the reactive intermediates. They either abstract Cl atoms from phosphorus trichloride to form $P^{32}Cl_3$ or combine to build up the polymeric red phosphorus. The chlorine abstraction requires an activation energy of at least 8.6 kcal/mole. The radiation chemical reaction is initiated by free radicals resulting from the radiolysis of the phosphorus trichloride. The reaction scheme proposed explains the chain character of the exchange reaction, its temperature dependence, and the formation of red phosphorus. (auth)

**28896** COMPARATIVE INVESTIGATION OF THE BEHAVIOR OF NIOBIUM, TANTALUM, AND PROTACTINIUM ON ION EXCHANGERS. Cornelius Keller (Technische Hochschule, Karlsruhe, Ger. and Kernreaktor Bau- und Betriebsgesellschaft mbH, Karlsruhe, Ger.). Radiochim. Acta, 1: 147-56(June 1963). (In German)

The behavior of several acidic solutions of niobium, tantalum, and protactinium in ion exchangers was studied at different acid concentrations, temperatures, and degrees of cross-linking in the exchanger. The results show that aqueous solutions of Pa(V) behave more regularly than those of Nb(V) and Ta(V). Pa tends less to hydrolysis in aqueous solution than Nb and Ta. A cation exchanger adsorbs the negative ionic species of Nb(V), Ta(V), and Pa(V) with partition coefficients only little smaller than those in an anion exchanger. For several exchange reactions of Pa(V) the enthalpy, entropy, and free energy values were calculated. (auth)

**28897** COMPLEX FORMATION IN MOLTEN SALTS STUDIED BY DISTRIBUTION METHODS. I. Co(II)-CHLORO COMPLEXES IN K–Li–$NO_3$. J. O. Liljenzin, H. Reinhardt, H. Wirries, and R. Lindner (CCR Euratom, Ispra, Italy). Radiochim. Acta, 1: 161-4(June 1963). (In English)

The distribution of cobalt between eutectic melts of K–Li–$NO_3$ with varying chloride concentration and suspended grains of γ-$Al_2O_3$ at 160°C was measured using $Co^{60}$ as tracer. By an iteration method of evaluation, the stability constants were determined for the following complexes: $CoCl^+$, $\beta_1 = 13.0$; $CoCl_2$, $\beta_2 = 104$; $CoCl_3^-$, $\beta_3 = 251$. (auth)

**28898** NEUTRON DIFFRACTION INVESTIGATION OF AN YTTRIUM–NEODYMIUM FERRITE WITH A GARNET STRUCTURE. Yu. S. Kuz'minov, I. I. Yamzin, and N. V. Belov (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 15-17 (July-Aug. 1963).

A polycrystalline specimen of yttrium-neodymium ferrite with the composition 1.5 $Y_2O_3$ 1.5 $Nd_2O_3$ 5$Fe_2O_3$ was studied. Nuclear and magnetic contributions to the diffraction maxima were calculated. The calculation of the magnetic contributions was based on three and two magnetic sublattices. From the experimental data it is concluded that neodymium ions do not produce magnetic scattering of neutrons. (auth)

**28899** A NEUTRON DIFFRACTION STUDY OF A MANGANESE–ZINC FERRITE. Yu. Ya. Konakhovich and Yu. G. Saksonov (Kurchatov Inst. of Atomic Energy, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 18-22(July-Aug. 1963).

A neutron-structural investigation of the mixed ferrite $Zn_{0.288}$ $Mn_{0.645}$ $Fe_{2.067}$ at room temperature in a magnetic field and at +260°C was presented. It was found that the oxygen parameter $u = 0.3881 \pm 0.0008$ and the degree of inversion of the ferrite is $\epsilon = 0.89 \pm 0.05$. It was found that ferrite has antiparallel arrangement of the cation magnetic moments at the tetrahedral and octahedral points; at room temperature the saturation magnetic moments of the ions in the tetrahedral and octahedral positions, based on one ion, are equal and have a value of $n = (3.3 \pm 0.9)\ \mu_B$/ion. The saturation magnetic moment for a molecule, $n = (3.3 \pm 0.9)\mu_B$, calculated from neutron-diffraction data agrees with the data for magnetic measurements of the specimen. (auth)

**28900** SELECTIVE ETCHING OF CESIUM IODIDE CRYSTALS. A. A. Urusovskaya (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 53-6(July-Aug. 1963).

An etchant was selected for revealing dislocations in cesium iodide crystals. A good selective etchant that may be used is, for example, a 0.025% solution of $CuCl_2$ in methyl alcohol. Correspondence of the etch pits to dislocations is confirmed by observation of the distribution of the pits on deformation and subsequent annealing of the CsI crystals. It is found that in cesium iodide at room temperature rapid relaxation occurs immediately after deformation. (auth)

**28901** AN X-RAY DIFFRACTION INVESTIGATION OF STRONTIUM-BISMUTH TITANATES OVER A WIDE RANGE OF TEMPERATURES. K. V. Kiseleva (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Cryst. (English Transl.), 8: 78-80(July-Aug. 1963).

The structure of strontium-bismuth titanates was investigated over a wide range of temperatures by x-ray diffraction methods to determine whether phase transitions exist in these materials. In the temperature range between +20 and −183°C there were no structural phase transitions and the cubic structure was retained in the temperature region below the temperature of maximum permittivity. The lattice parameters were also calculated. (C.E.S.)

**28902** DETECTION OF DOMAIN STRUCTURE IN AMMONIUM FLUOBERYLLATE CRYSTALS. S. D. Toshev (Moscow State Univ.). Soviet Phys.-Cryst. (English Transl.), 8: 87-8(July-Aug. 1963).

The domain structure of ammonium fluoberyllate crystals were detected by cutting a plate perpendicular to the piezoelectric axis and immersing it in liquid nitrogen. The cooled specimen was transferred to a microscope and the pattern of the crystallization of frost along the domain boundaries was observed in reflected light. In the course of time the snow bands thickened and after several tens of seconds coalesced with adjacent bands. Similar orientation of the crystallization of frost was also observed on crystal faces cut perpendicular to the piezoelectric axis. (C.E.S.)

**28903** EFFECT OF DRYING TEMPERATURE ON THE ION-EXCHANGE PROPERTIES OF ZIRCONIUM PHOSPHATE. Giulio Alberti and Arminio Conte (CNRN, Rome). Studi Ric. Div. Geomineraria, Comit. Nazl. Ric. Nucl., 3: 433-45(1960). (RT/GEO(63)12). (In Italian)

The ion-exchange properties of zirconium phosphate, dried at temperatures ranging from 150 to 850°, were compared with those of zirconium phosphate dried at 50°. In addition to partially irreversible dehydration, permanent changes in certain properties of zirconium phosphate dried

at temperatures above 150° were observed. Variations in selectivity for certain ions of ZP dried at high temperature can be employed to improve the separation of the ions from each other. All phenomena observed can be explained by the assumption that an increase in drying temperature causes a greater condensation in the structure of the exchanger. (auth)

**28904** ON THE FORMATION OF THE TETRAGONAL BORON MODIFICATION BY SUBSTITUTION OF THE BERYLLIUM ATOM IN THE LATTICE OF $BeB_{12}$. H. J. Becher (Technische Hochschule, Stuttgart). Z. Anorg. Allgem. Chem., 321: 217-23(Apr. 1963). (In German)

By heating $BeB_{12}$ with $BCl_3$ in a closed tube, Be was substituted by B without changing the crystal structure. The boron obtained was of >99% purity and tetragonal structure. By this reaction the structural relation between $BeB_{12}$ and the tetragonal boron modification was proved. Infrared examinations of α-boron, tetragonal boron, and $BeB_{12}$ allowed the assignment of internal vibrations of the $B_{12}$-icosaedrons and of lattice vibrations. (auth)

**28905** REPORT ON THE POLYMORPHISM OF THE SESQUIOXIDES OF THE RARE EARTHS. Georg Brauer and Rainer Mueller (Universität, Freiburg i. B.). Z. Anorg. Allgem. Chem., 321: 234-45(Apr. 1963). (In German)

The transformation from the C to the B form of the sesquioxides of samarium, europium, and gadolinium was investigated. The minimum temperature of the beginning of this transformation and its reaction rate depend considerably on the chemical preparation and thermal treatment of each sample. A relation between these particular phenomena can be derived from the observation of the density of the oxide samples before, during, and after the transformation. (auth)

**28906** THE SOLUBILITY OF VARIOUS METALS IN MERCURY. Gerhard Jangg and Heinz Palman (Technische Hochschule, Vienna). Z. Metallk., 54: 364-9(June 1963). (In German)

A method for the determination of the solubility of metals in mercury is discussed. This method is based on the analytical determination of the metal content of filtered saturated amalgams. For investigations in the temperature ranges above and below the boiling point, two different apparatuses were developed for use. With this method the solubilities of Al and Ag could be confirmed. It could be decided between the contradictory results of the solubility of U and Th in the literature. The unknown solubilities of Cu, Mn, Ni, Sb, Ti, Co, and Cr were determined. The temperature dependence of the solubility was plotted as log L vs. 1/T curves. In systems which form intermetallic compounds a break in these curves was observed at the peritectic temperature. Also it was confirmed that the heat of solution is about equal for all metals. On this basis values for the solubility of Fe taken from the literature were critically reviewed. (auth)

**28907** THE INFLUENCE OF $OH^-$ IONS ON THE ABSORPTION SPECTRUM AND IONIC CONDUCTIVITY OF KCl SINGLE CRYSTALS. Bernd Fritz, Fritz Luety, and Joerg Anger (Technische Hochschule, Stuttgart). Z. Physik, 174: 240-56(1963). (In German)

Air-grown KCl crystals (undoped or doped with KOH) contain two types of $OH^-$ impurities: a free $OH^-$ ion, probably in a substitutional position and a reaction product involving divalent impurities like $Ca^{2+}$. The free ion absorbs in two bands in the ultraviolet (204 mμ) and infrared region (2.8 μ). From concentration measurements by titration of KOH doped crystals, both bands were found to be very weak, the uv band having an oscillator strength of f = 0.13, the infrared band showing 1.2% of the absorption expected from oscillators with appropriate mass and unit dipole charge. In the same crystals, strong carbonate bands (7 μ) were observed; the corresponding $CO_3^{2-}$ concentration, however, was low (less than 3% of the $OH^-$ present), according to measurements on samples with known $CO_3^{2-}$ content. Investigations of the ionic conductivity of KOH doped crystals gave evidence of a reaction in the crystal between $OH^-$ and $Ca^{2+}$ impurities, as the product of this reaction showed no uv absorption, but an OH infrared absorption; and strongly suppressed the extrinsic conductivity to be expected from the $Ca^{2+}$ ions present in the crystal. The consequences of this reaction for conductivity measurements on air-grown KCl without any doping to the melt are demonstrated and the results discussed. (auth)

**28908** BASIC THORIUM ACETATE. K. N. Kovalenko, D. V. Kazachenko, and O. N. Samsonova. Zh. Neorgan. Khim., 8: 797-801(Apr. 1963). (In Russian)

Thorium acetate $(CH_3COO)_3ThOH$ was prepared by reaction of $Th(NO_3)_4 \cdot 2.75\ H_2O$ with acetic acid in saturated acetone solutions. A thermographic analysis established the density of $ThOH(CH_3COO)_3$ as 2.499 g/cm³ at 20°. Photocolorimetric studies using thoron determined the basic thorium acetate solubility as a function of pH in aqueous solutions. The presence of one $OH^-$ group was confirmed and solubility of $ThOH(CH_3COO)_3$ at 20° was determined to be $5.4 \times 10^{-23}$. (R.V.J.)

**28909** POLYOXY IONS. K. B. Yatsimirskii. Zh. Neorgan. Khim., 8: 811-16(Apr. 1963). (In Russian)

Stability factors for various types of polyoxycations were studied and the relation between polyoxycation stability and their charges, radii and electron structure were determined. The origin of supplementary absorption bands was found and the polyoxyanion formation as a function of relative π-bond stability between central atom and atom of oxygen was studied. It was also shown that reduced temperature and increased ion force shift the solution equilibrium to the polyoxycation side. (R.V.J.)

**28910** ON THE FORMATION OF $Th[(OH)_4Th]_{n_1}^{4+}$ IONS. A. I. Zhukov, V. N. Onosov, V. Ya. Kudyakov, and B. M. Sergeev (Ural Polytechnic Inst., USSR). Zh. Neorgan. Khim., 8: 871-5(Apr. 1963). (In Russian)

Conditions for Th elution from ionite by ammonium chloride solutions were studied, and formation of $Th[(OH)_4Th]_{n_1}^{4+}$ ions in the presence of an ionite was analyzed. A complete thorium elution from KU-1 was achieved with pH 2.75 at 90° resulting in 0.025 mole/l Th concentration in the solution. Sorption of Th by KU-1 and KU-2 cations followed by ammonium chloride elution confirmed the postulation that $Th[(OH)_4Th]_{n_1}^{4+}$ is formed by sufficiently high thorium concentrations in the ionite phase. Precipitation of basic salts during thorium salt neutralization is also considered as the result of $n_1$ increase in complex $Th[(OH)_4Th]_{n_1}^{4+}$ cations. (R.V.J.)

**28911** EFFECTS OF LIGAND FIELDS ON OXIDATION-REDUCTION PROPERTIES OF TRANSITION ELEMENTS. K. B. Yatsimirskii (Ivanov Inst. of Chemistry and Tech., USSR). Zh. Neorgan. Khim., 8: 876-81(Apr. 1963). (In Russian)

Effects of ligand fields on redox in transition elements were studied, and it was found that the stability of various d-electron compound, depends on crystalline field, spatial distribution of adjacent atoms and acting field force. The magnitude of Sc, Ti, V, Cr, Mn, Fe, Co, Ni, and Zr redox potential affected by ligand component fields were calculated. (R.V.J.)

**28912** ALKALINE EARTH METAL OXALATE–ZIRCONATES. V. P. Shvedov, N. A. Susorova. Zh. Neorgan. Khim., 8: 893-5(Apr. 1963). (In Russian)

Preparation of complex salts of $Me_2[Zr(C_2O_4)_4]_4 \cdot nH_2O$ by Zr with $Ca^{2+}$, $Sr^{2+}$, and $Ba^{2+}$ reaction with oxalic acid saturated with 0.1N $HNO_3$ was studied. Solubility of prepared complex compounds in $HNO_3$ and HCl aqueous solutions was determined. Solubility data indicated an increased oxidation resistance with an increase of the amount of cations. Solubility of complex $Ca^{2+}$, $Sr^{2+}$, and $Ba^{2+}$ salts with zirconium oxalate ion was estimated. (R.V.J.)

**28913** COMPLEX FORMATION OF RARE EARTHS WITH ETHYLENEDIAMINETETRAACETIC ACID. Yu. P. Galaktionov and K. V. Astakhov (Moscow Inst. of Fine Chemical Tech.). Zh. Neorgan. Khim., 8: 896-904(Apr. 1963). (In Russian)

Spectrophotometric investigations of complex formation of $Sm^3$ and $Eu^{3+}$ with ethylenediaminetetraacetic acid are described. The types of complexes (1:1 and 1:2) were found by a method of isomolar series, by series of solutions with constant ion-complex formation concentration and variable-complexing substance as well as by a series of solutions with constant complexing substance and variable ion-complex formation. The pH magnitudes of complexes were found and formation constants and instability constants $MeH_3Y^2$, MeHY, $MeY^-$, $MeHY_2^{4-}$, $MeY_2^{5-}$, and $MeY_2OH^{5-}$ were determined. (R.V.J.)

**28914** TERNARY LEAD, LITHIUM, AND CADMIUM CHLORIDE SYSTEM. A. G. Bergman, A. P. Sadovskii, and Zh. V. Misler. Zh. Neorgan. Khim., 8: 954-8(Apr. 1963). (In Russian)

The liquidus diagram of $CdCl_2$–$Li_2Cl_2$ system indicated the presence of two compounds. The recovered composition 2 $PbCl_2 \cdot 3$ $CdCl_2$ differs from the composition previously reported in the literature. X-ray analysis indicated that the compound decomposes at room temperature. Seven fields of crystallization were found in the ternary Li, Cd, Pb–Cl system. $PbCl_2$, $LiCl_2$, $CdCl_2$, $Li_2Cl_2 \cdot CdCl_2$, $3\ Li_2Cl_2 \cdot 2\ CdCl_2$, $2\ PbCl_2 \cdot 3\ CdCl_2$, and $Li_2Cl_2 \cdot 2\ CdCl_2$ formed in the solidus of the $Li_2Cl_2$–$CdCl_2$ system. (R.V.J.)

**28915** THE $Nb_2O_5$–$SO_3$–$H_2O$ SYSTEM. Ya. G. Goroshchenko and M. I. Andreeva. Zh. Neorgan. Khim., 8: 981-5 (Apr. 1963). (In Russian)

The solubility of $Nb_2O_5$–$SO_3$–$H_2O$ system at $SO_3$ concentration 10 to 90% and 100 to 200°C was studied, and solubility isotherms were constructed. The $Nb_2O_5(SO_4)_3$ and $Nb_2O(SO_4)_4$ compounds were prepared by direct solubility method. (R.V.J.)

**28916** SOLUBILITY OF PRASEODYMIUM AND NEODYMIUM CHLORIDES IN ORDINARY ALCOHOLS AT 0, 25, AND 50°C AND THERMOGRAPHY OF CRYSTAL SOLVATES. Z. I. Grigorovich (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 8: 986-9(Apr. 1963). (In Russian)

Solubility of $PrCl_3$ and $NdCl_3$ in ordinary alcohols (from methyl to amyl) was studied considering the composition of donor phases and the behavior of examined compounds during heating of crystal solvates. The solubility of $PrCl_3$ was found to be higher than $NdCl_3$. (R.V.J.)

**28917** COMPLEX HAFNIUM RHODANIDES. I. V. Tananaev, I. A. Rozanov, and A. G. Kolgushkina (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 8: 1013-14(Apr. 1963). (In Russian)

Physical and chemical studies were made of prepared complex compounds of hafnium rhodanates $Cs[HfO(NCS)_3 \times H_2O]H_2O$, $PyH[HfO(NCS)_3H_2O]$ and $(PyH)_2[(HfO)_2(NCS)_7]H_2O$. Pyridine hexarhodanohafnate $(PyH)_2[Hf(NCS)_6]$ was extracted from 2 mole/l concentration hydrochloric acid solution. (R.V.J.)

## Organic Chemistry

**28918** (AEEW-R-256) PHYSICAL PROPERTIES OF ORGANIC COOLANTS. A. G. Debbage, D. A. Garton, and J. H. Kinneir (United Kingdom Atomic Energy Authority, Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Mar. 1963. 41p.

Density, viscosity, specific heat, vapor pressure, and calorific value were measured within the temperature range 100 to 400°C for mixtures of Santowax R with pyrolytic high boiler and with OMRE radiolytic high boiler; in addition, measurements were made on Santowax OM, X-7 standard, X-7 loop, and OMRE coolants. The accuracies of the measurements made were density (±¼%), viscosity (±2%), specific heat (±2%), vapor pressure (±2%), and calorific value (±½%). Thermal conductivity was calculated from an improved form of the Smiths equation with an accuracy within ±6%. Equations fitted to the vapor pressure results were used to provide data outside the experimental range for burnout correlation purposes. The general effect of high boiler content on the specific heat and calorific values was small. The differences in physical property values for corresponding values of either pyrolytic or radiolytic high boiler were small for density (0.3%) and specific heat (2%), but quite large for viscosity (70%) with the pyrolytic high boiler mixture giving the higher value. The chemical analysis of all materials was based on gas chromatography and the relationship between this and an earlier distillation method established. (auth)

**28919** (ORNL-TM-625) SYNTHESES OF o-NITROPHENYLARSONIC ACID, o-AMINOPHENYLARSONIC ACID AND ARSENAZO III. H. L. Holsopple (Oak Ridge National Lab., Tenn.). July 12, 1963. Contract [W-7405-eng-26]. 6p.

Methods are given for the successive syntheses of three compounds: o-nitrophenylarsonic acid by the interaction of diazotized o-nitroanaline with an alkaline solution of sodium arsenite; o-aminophenylarsonic acid by reducing o-nitrophenylarsonic acid with ferrous chloride and sodium hydroxide; and arsenazo III (1,8-dihydroxynaphthalene 3,6-disulfonic acid-2,7-bis[(azo-2)-phenylarsonic acid]) by the azo addition of diazotized o-aminophenylarsonic acid and chromotropic acid. (auth)

**28920** (PAEC(D)CH-634) RELATIVE STABILITIES OF SOME CONJUGATED OLEFINS. O. S. Pascual and E. Almeda (Philippines. Atomic Energy Commission, Manila). 1963. 9p.

The conjugated olefins included the isomer pairs: 1-methyl-2,6-cyclohexadiene and 1-methylene-2-cyclohexene; and 1-methylcyclohexene and methylenecyclohexane. The olefins were synthesized and their heats of combustion were determined. It was noted that the isomer with the smaller heat of combustion was the more stable of the pair. (B.O.G.)

**28921** (PAEC(D)CH-635) RELATIVE STABILITIES OF SOME ALLYLIC CYCLIC ISOMERS. O. S. Pascual and Zenaida S. Garcia (Philippines. Atomic Energy Commission, Manila). 1963. 8p.

The relative thermochemical stabilities of the allylic pair 2-methylenecyclohexanol and 1-cyclohexenemethanol and their 5-ring homologs are compared by their heats of combustion. Methods of preparation are given for the above mentioned compounds and 2-methylenecyclopentanol, 1-

cyclopentenemethanol, 2-methylcyclopentanone, and 2-methylcyclohexanone. (N.W.R.)

**28922** (PAEC(D)CH-636) BOND FIXATION IN BENZENE AND ITS DERIVATIVES. O. S. Pascual (Philippines. Atomic Energy Commission, Manila). 1963. 5p.

Bond fixation in benzene and its derivatives is discussed with respect to orientations, polar and steric effects, and carbon and hydrogen bonding. Fifteen compounds are discussed with respect to bond fixation. (N.W.R.)

**28923** (TID-18976) THE ABSORPTION OF SOUND IN METHANE-$D_2$ (thesis). Louis Raymond Dragonette (Vanderbilt Univ., Nashville. Graduate School). June 1963. 59p.

Using the sound tube method, the effect of deuteration on the absorption of sound in methane was investigated. The apparatus employed a movable electrostatic speaker and a fixed ribbon-type microphone, both enclosed in a cylindrical glass tube. The microphone output level was plotted as a function of the distance between speaker and microphone for various frequency over pressure ratios. The total absorption was derived from the slopes of the lines obtained. When the classical and tube absorptions were calculated and subtracted from the total absorption, the relaxation absorption was obtained. A plot of relaxation absorption versus the logarithm of the frequency over pressure ratio produced a bell shaped curve, which gave the experimental maximum relaxation absorption and the frequency at which it occurred. Good agreement existed between the experimental maximum relaxation absorption of 0.127 nepers/wavelength and the theoretical value of 0.121 nepers/wavelength. The frequency at which maximum absorption occurred was 146 kilocycles, corresponding to a relaxation time of 1.26 microseconds for methane-$d_2$. In order to demonstrate a connection between relaxation time and transition probabilities, the number of first excited state to ground state transitions per excited molecule, per second calculated to be $2.93 \times 10^6$. For each of the three organic gases, methane, acetylene, and ethylene, the numerical value of $A_m$ (relaxation absorption) is increased upon substitution of heavy hydrogen atoms for normal hydrogen in the respective molecules. Deuteration in methane produced both a decrease in the frequency at which maximum absorption occurs and an increase in the relaxation time; whereas deuteration in ethylene increased both these quantities, and deuteration acetylene increased the frequency and decreased the relaxation time. It thus appears that at present there is no way to predict the effect of deuteration upon the relaxation time of organic molecules. (auth)

**28924** (TID-18995) PHYSICAL PROPERTIES OF POLYPHENYLS. W. H. Hedley, M. V. Milnes, and W. H. Yanko (Monsanto Research Corp. Dayton Labs., Ohio). [1962]. Contracts AT(11-1)-705 and AT(10-1)-1088. 21p.

Viscosity and thermal conductivity data for liquid and vapor biphenyl and o-, m-, and p-terphenyl (all 99.5 +% pure) were determined for use in heat transfer correlations. The liquid properties were measured over a temperature range at atmospheric pressure, and equations were fitted to the data. Liquid viscosities were measured using capillary viscometers, and thermal conductivities were determined with a hot wire apparatus. Vapor viscosity and thermal conductivities were calculated at low pressure and at saturation. Equations for low-pressure vapor viscosity were developed by the Bromley-Wilke method, and for low-pressure vapor thermal conductivity by the method of Bromley. For the saturated vapors, viscosity equations were established using the method of Grunberg and Nissan, and thermal conductivity equations were established based on a corresponding pressure states relation. Using these equations, liquid and vapor viscosity and thermal conductivity values were calculated up to at least 850°F in 10°F increments by an IBM-704 computer. Comparative heat transfer properties, evaluated using the above properties, are reported. (auth)

**28925** ISOTOPE EFFECT STUDIES ON ELIMINATION REACTIONS. III. NITROGEN ISOTOPE EFFECTS IN THE E2 REACTION OF ETHYLTRIMETHYLAMMONIUM AND 2-PHENYLETHYLTRIMETHYLAMMONIUM IONS. G. Ayrey, A. N. Bourns, and V. A. Vyas (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 41: 1759-67(July 1963).

Nitrogen isotope effects were determined for the E2 reaction of two quaternary ammonium salts with ethoxide ion in ethanol. Ethyltrimethylammonium iodide gave $k^{14}/k^{15}$ values of 1.017 at 60° and 1.015 at 95°, while 2-phenylethyltrimethylammonium bromide gave 1.012 at 40° and 1.009 at 60°. These results and the $\beta$-deuterium isotope effects reported by others were interpreted in terms of the relative extent of $C_\alpha-N^+$ and $C_\beta-H$ bond weakening in the transition states of the two reactions. (auth)

**28926** FUNDAMENTAL VIBRATIONAL FREQUENCIES IN KETENE AND THE DEUTEROKETENES. A. Peter Cox and Alan S. Esbitt (Harvard Univ., Cambridge Mass.). J. Chem. Phys., 38: 1636-43(Apr. 1, 1963).

Accurate microwave relative intensity measurements were made on rotational transitions of ketene and its deutero derivatives in the ground and first vibrational states. The results allow the three lowest fundamental frequencies of these molecules to be positively determined. For $CH_2CO$, these modes are found to be 443, 527, and 617 $cm^{-1}$. The lowest frequency is nearly 100 $cm^{-1}$ lower than any fundamental previously cited from infrared data for ketene. To substantiate the microwave results, solid-state infrared spectra of the molecules at -192° were investigated in the region 300 to 4000 $cm^{-1}$. The low-frequency spectra are in good agreement with the microwave data, and a complete analysis allows the nine fundamentals of $CH_2CO$, $CHDCO$, and $CD_2CO$ to be evaluated. The three lowest fundamentals of $CH_2CO$ in the solid are found at 433, 513, and 613 $cm^{-1}$. The thermodynamic properties of ketene were recalculated. (auth)

**28927** STRUCTURE OF FORMALDOXIME. Ira N. Levine (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 38: 2326-8(May 15, 1963).

The microwave spectra of cis-CHDNOH, trans-CHDNOH, $C^{13}H_2NOH$, $CH_2N^{15}OH$, and $CH_2NO^{18}H$ were assigned. Together with the results of previous work on the normal species and $CH_2NOD$, the data give the following planar structure for formaldoxime: bond lengths in Å; $CH_{cis}$ = 1.085, $CH_{trans}$ = 1.086, C = N = 1.276, NO = 1.408, OH = 0.956; bond angles; $H_{cis}CN$ 121°46', $H_{trans}CN$ 115°33', CNO 110°12', NOH 102°41'. The most significant feature of the structure is the difference between cis- and trans-HCN bond angles. This "tilt" of the methylene group appears to be too large to be attributed to steric repulsion. The C = N and N-O bond lengths are consistent with the Schomaker-Stevenson relation if allowance for resonance is made. (auth)

**28928** HETEROALICYCLIC ANALOGS OF 2- AND 3-AMINOALKANETHIOLS. James R. Piper and Thomas P. Johnston (Southern Research Inst., Birmingham, Ala.). J. Org. Chem., 28: 981-5(Apr. 1963).

Heteroalicyclic analogs of 2- and 3-aminoalkanethiols were synthesized from the alkanols Ia-Va via the corresponding halogenoalkylamine hydrohalides for evaluation as

antiradiation drugs. The analogs described have mercapto (or potential mercapto) groups on a side chain two or three carbon atoms removed from the secondary amino groups of pyrrolidine, piperidine, thiomorpholine, and piperazine. The bicyclic dithiocarbamates VIII and IX resulted from the reaction of carbon disulfide with 2-(chloromethyl) pyrrolidine hydrochloride (Ib) and 2-(2-chloroethyl)piperidine hydrochloride (IIIc), respectively. The synthesis of VIII elucidated the structure of the water-insoluble product formed concurrently with 2-pyrrolidinylmethyl dimethyldithiocarbamate hydrochloride (Id) from Ib and sodium dimethyldithiocarbamate. (auth)

**28929** REACTION BETWEEN 1-HEXENE AND HYDROGEN AND DEUTERIUM ON COPPER–CHROMIUM OXIDE CATALYST. Isao Matsuzaki and Robert L. Burwell, Jr. (Northwestern Univ., Evanston, Ill.). J. Phys. Chem., 67: 608-12(Mar. 1963).

Reaction of hydrogen and deuterium with 1-hexene was investigated in a vapor phase, flow reactor on copper-chromium oxide catalyst at temperatures of from 50 to 150°. The catalyst was pretreated with hydrogen at 325°. There are three primary reactions, hydrogenation, isomerization to trans- and cis-2-hexene which appear in a ratio of about 10, and formation of isotopically exchanged 1-hexene. The last reaction is the fastest and, as shown by n.m.r., it involves almost exclusively exchange at carbon atom-2 to form 1-hexene-2-d. The activation energy for isomerization is about 5 kcal greater than that for hydrogenation. The rates of the two reactions are equal at about 90°. At 60°, presence of 1-hexene almost completely inhibits hydrogenation of 2-hexene but it does not inhibit isomerization of 2- to 3-hexene. The isotopic distribution pattern of the hexene formed at low conversions seems to result from the addition of two (H,D) atoms to a mixture of 1-hexene and 1-hexene-2-d formed by previous exchange. Thus, during the course of hydrogenation, there seems to be little tendency for reversion of diadsorbed hexane to monoadsorbed. Isotopic distribution patterns for trans-2-hexene are presented and difficulties in the application of the Horiuti–Polanyi mechanism to olefin isomerization and exchange are discussed. (auth)

**28930** ELECTRON IMPACT INVESTIGATIONS OF SULFUR COMPOUNDS. II. 3-METHYL-2-THIABUTANE, 4-THIA-1-PENTENE, AND 3,4-DITHIAHEXANE. Brice G. Hobrock and Robert W. Kiser (Kansas State Univ., Manhattan). J. Phys. Chem., 67: 648-50(Mar. 1963).

Appearance potentials and relative abundances of the principal positive ions from 3-methyl-2-thiabutane, 4-thia-1-pentene, and 3,4-dithiahexane are reported. Probable ionization and dissociation processes are postulated in agreement with the computed energetics. Heats of formation, consistent with the proposed processes, are given. From appearance potential data, the ionization potential of $C_2H_5SSH$ is derived to be 9.4 ± 0.3 ev, in agreement with the group orbital calculations. More accurate values for the proton affinities of hydrogen sulfide and methanethiol are found to be −197 ± 7 and −199 ± 10 kcal/mole, respectively. (auth)

**28931** TEMPERATURE DEPENDENCE OF THE CARBON ISOTOPE EFFECT IN THE DECARBONYLATION OF LIQUID FORMIC ACID. Peter E. Yankwich and Rudy H. Haschemeyer (Univ. of Illinois, Urbana). J. Phys. Chem., 67: 694-6(Mar. 1963). (TID-16839)

The $C^{13}$ kinetic isotope fractionation in the decarbonylation of liquid formic acid was studied over the range 59.8 to 100.0°; ($k_{12}/k_{13}$) lay in the range 1.05 to 1.04. The observed temperature dependence was examined by the "gamma-bar" method of Bigeleisen and Wolfsberg, the "semi-empirical" method of Yankwich, Weber, and Ikeda, and several "two-center" approaches. Of the approximately 4.5% isotope effect, only a few tenths of a per cent is temperature independent; the calculated sums of the differences upon activation of the diagonal cartesian force constants correspond especially well with the value expected for C–O bond rupture, and indicate strongly that this rupture is a major component of the reaction coördinate motion. (auth)

**28932** THE DEUTERIUM ISOTOPE EFFECT IN THE HYDROGEN BONDING OF IMIDAZOLE IN NAPHTHALENE SOLUTIONS. Alec Grimison (Univ. of Puerto Rico, Rio Piedras, P.R.). J. Phys. Chem., 67: 962-4(May 1963).

A study was made of the self-association of imidazole and 1-d-imidazole in naphthalene solution at 80°C. Under these conditions imidazole forms linear oligomers through N–H–N hydrogen bonding. The deuterium compound was found to be less associated, by about 8%, than the hydrogen analog. This difference is analyzed in terms of the equilibrium constants and free-energy changes for the various association equilibria. For dimerization the results give a $\Delta F^0$ of −1100 cal/mole for imidazole, and a $\Delta F^0$ of −1020 cal/mole for 1-d-imidazole. This implies weaker hydrogen bonding by deuterium. (auth)

**28933** THE MASS SPECTRA OF THREE DEUTERATED PROPENES. W. H. McFadden (Western Regional Research Lab., Albany, Calif.). J. Phys. Chem., 67: 1074-7(May 1963).

The mass spectra of 2-$D_1$-propene, 1,1-$D_2$-propene, and 3,3,3-$D_3$-propene are presented for 70 volt electrons. The data show considerable rearrangement of hydrogen and deuterium from all positions. The formation of $C_3H_3^+$ is due primarily to loss of hydrogen from positions 1 or 3. The rate of loss of $CH_3$ or $CH_4$ to form two carbon ions is sufficiently fast to allow only a few exchanges of hydrogen and deuterium prior to this breakdown. (auth)

**28934** LABILIZATION OF THE α-HYDROGEN ATOM OF GENERALLY LABELLED TRITIATED L-α-AMINO-ACIDS IN THE PRESENCE OF RENAL D-AMINO-ACID OXIDASE. E. A. Evans, R. H. Green, J. A. Spanner, and W. R. Waterfield (Radiochemical Center, Amersham, Bucks, Eng.). Nature, 198: 1301-2(June 29, 1963).

The specific activity of L-amino acids isolated after D-amino-acid oxidase treatment of the corresponding tritium-labeled DL-compound was much lower than expected. It is shown that the tritium loss occurs at the asymmetric α-carbon atom in the DL-compound. It is suggested that the α-hydrogen atom of the L-isomer is involved in the oxidase process. (D.L.C.)

**28935** EVALUATION OF THE PREPARATION OF ETHYLENE-$O_4$ BY REDUCTIVE DEHALOGENATION OF TETRACHLOROETHYLENE. D. M. Sharefkin, R. Sallé, and L. Pichat (Centre d'Etudes Nucleaires, Saclay, France). Radiochim. Acta, 1: 87-9(Jan. 1963). (In French)

An evaluation was made of the reductive dehalogenation of tetrachloroethylene by zinc and heavy water in the presence of dioxane, sodium iodide, and copper chloride as a method of preparation of ethylene-$D_4$. (auth)

**28936** TRITIUM LABELING ON A NICKEL CATALYST. M. A. Long, A. L. Odell, J. M. Thorp (Univ. of Auckland, N. Z.). Radiochim. Acta, 1: 174-6(June 1963). (In English)

In an attempt to find a general catalytic method of labeling, utilizing tritium gas, exchange reactions between

tritium gas and cyclohexane, cyclohexene, benzene, toluene, and acetone on nickel catalysts were studied. Using this method hydrocarbons were labeled to a high level of activity with less than 0.1% of this activity in damage products. This was in contrast to the Wilzbach method where some 70% of the activity is typically found in impurities produced during the exposure. (M.C.G.)

## Radiation Chemistry and Radiochemistry

*Refer also to abstract 28638.*

**28937** (AWRE-O-16/63) THE INTERACTION OF TRITIUM GAS WITH POLYTHENE. P. M. S. Jones and R. Gibson (United Kingdom Atomic Energy Authority, Weapons Group. Atomic Weapons Research Establishment, Aldermaston Berks, England). July 1963. 17p.

The hydrogen yield from a linear polyethylene subjected to radiolysis by tritium $\beta$ particles was measured. The $G(H_2)$ value is 3.1 ± 0.05 molecules/100 ev. The rate of isotopic exchange between tritium gas and solid polyethylene powder was studied for two geometries and the results are shown to be consistent with exchange initiated by tritium atoms produced in the gas phase rather than species produced in the solid phase during radiolysis. (auth)

**28938** (BNL-6401) RADIATION DAMAGE IN SOLID TETRAMETHYL AMMONIUM HALIDES. FREE RADICALS STABLE AT LOW TEMPERATURE. A. J. Tench (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 7p.

Electron spin resonance (ESR) spectral studies were carried out on tetramethyl ammonium halides which were irradiated at 298 and 77°K. The ESR spectra of the iodide and bromide irradiated at 298°K consisted of a single line of width 30 to 40 gauss, while that of the chloride gave a weak complex pattern. When the irradiations and ESR studies were performed at 77°K, considerable fine structure was observed which was centered about g = 2.003 ± 0.001. The iodide spectrum at 77°K is a quartet superimposed on a broad line and is not materially affected by thermal annealing at 148°K. The quartet is identified as a methyl radical. The bromide spectrum at 77°K consists of a quartet superimposed on a triplet, and thermal annealing at 148°K reduces it to a triplet and at 298°K to a single broad line. The triplet appears to be $(CH_3)_2NCH_2$ •. The chloride spectrum is similar to the bromide except that the quartet is just observable and slowly anneals at 77°K. (D.L.C.)

**28939** (ORNL-3461) AN ANNOTATED BIBLIOGRAPHY ON THE EFFECTS OF RADIATION ON HETEROGENEOUSLY CATALYZED REACTIONS AND ON CHEMISORPTION. N. A. Krohn (Oak Ridge National Lab., Tenn.). July 17, 1963. Contract W-7405-eng-26. 69p.

The 264 references were compiled primarily from a search of Chemical Abstracts, Nuclear Science Abstracts, and Dissertation Abstracts through December 1962. The annotations give the type of radiation, the catalysts investigated, and the test reactions used. The entries are cross-referenced, and indexes of the authors, catalysts, reactions, and type of radiation are provided. The compilation is limited to papers in which either heterogeneously catalyzed reactions, chemisorption, or the radiolysis of adsorbed substances was studied. Papers on the effects of ultraviolet light are not included. (auth)

**28940** (TID-17132) PHOTOLYSIS OF HI WITH 1849 Å RADIATION: HOT HYDROGEN ATOM REACTIONS. R. M. Martin, E. Murad, and J. E. Willard (Wisconsin. Univ., Madison). [1962]. Contract AT(11-1)-32. 28p.

Quantum yields greater than unity for $H_2$ and $I_2$ formation in the gas phase photolysis of HI were observed using 1849 Å radiation, in contrast to the yield of unity found at higher wavelengths. This result indicates that following the primary dissociation hot H atom energy is used to break more than one additional HI bond. The primary process is discussed, and mechanisms are postulated involving the transfer of translational energy of hot species to vibrational energy of HI molecules, and the reaction of vibrationally excited HI molecules with thermal HI molecules. Absorption of 1849 Å radiation by $I_2$ in HI–$I_2$ mixtures is able to lead to decomposition of HI with quantum yields in the range of unity. (auth)

**28941** (TID-18904) SYSTEMATICS OF MÖSSBAUER ISOMER SHIFTS OF IRON-ORGANIC COMPOUNDS. R. H. Herber (Rutgers Univ., New Brunswick, N. J. Ralph G. Wright Chemical Lab.); R. B. King (Mellon Inst., Pittsburgh); and G. K. Wertheim (Bell Telephone Labs., Inc., Murray Hill, N. J.). [1963]. Contract AT(30-1)-2472. 32p.

The resonant gamma-ray absorption spectra of 51 iron-organic compounds were obtained at 78°K, and quadrupole splittings and isomer shifts (referred to a source of $Co^{57}$ diffused into metallic chromium) were determined. The latter parameter, which is sensitive to the chemical environment of the iron atom, can be treated as the sum of the partial isomer shifts, $\xi$, of the individual ligands. For ligands without appreciable electron delocalization, a single $\xi$ value satisfies the additivity properties of the partial isomer shift. For $\pi$-cyclopentadienyl derivatives, the appropriate $\xi$ value can be correlated with proton nmr chemical shifts. Inequality of the intensity of the two components of quadrupole split resonance lines was observed in a number of polycrystalline metal organic compounds. This asymmetry is related to the anisotropy of the recoil-free fraction relative to the crystallographic axes of individual crystallites. 41 references. (auth)

**28942** (TID-18905) CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS. R. H. Herber (Rutgers Univ., New Brunswick, N. J.). [1963]. Contract AT(30-1)-2472. 20p.

A symposium was held in Amsterdam on May 1 to 3, 1963, in order to review the field of hot-atom chemistry. The progress in this field can be summarized as follows: (1) A general theory probably will not be possible in this field. (2) Many techniques are used, and conflicting results are often obtained. (3) Tritium- and carbon-recoil reactions have been thoroughly studied. (4) The initial hot-atom energy has little bearing on the final chemical fate of the hot atom. Summaries of the individual papers are also presented. (D.L.C.)

**28943** (TID-18961) NUCLEAR CHEMISTRY RESEARCH AT CARNEGIE INSTITUTE OF TECHNOLOGY 1962-1963. Progress Report. (Carnegie Inst. of Tech., Pittsburgh). June 1, 1963. Contract AT(30-1)-844. 105p.

Progress is reported on: nuclear reaction studies of cross sections of iron and stone meteoritic elements for 130- to 400-Mev protons, simulated cosmic-ray irradiations of thick iron and stone targets with 100-Mev to 3-Bev protons, and induced alpha-activity in short half-life ranges; nuclear geochemistry and cosmochemistry studies of nuclide dating of sediments, pseudo-diffusion in ocean and Maria sediments, cosmogenic radionuclides in iron and stone meteorites, cosmogenic radionuclides in Bondoc Achondrite and Bogou iron, half life of $Mn^{53}$, cosmogenic radioactivity in fragments of Sputnik IV, $Be^{10}$ occurrence

in tektites, and conversion of sealed anticoincidence shield counters to flow counters; and the search for natural radioactivity in $Ca^{48}$. (B.O.G.)

**28944** (TID-18983) EFFECT OF RADIATION ON DYNAMIC PROPERTIES OF HIGH POLYMERS. Progress Report, July 1962 to June 1963. J. A. Sauer (Pennsylvania State Univ., University Park). July 1963. Contract AT(30-1)-1858. 15p.

Accomplishments of the project during the last 12 months are reviewed. Information concerning the onset of internal transitions and molecular motions in solid polymers is discussed. Studies are being made of polymers of varying composition and structure, of the effect of irradiation on properties and structure of polymers, and of the mechanism of growth of polymer single crystals. The developments that occurred in the internal friction studies at low temperature, in the NMR studies of local side branch motions, and in the studies of relaxation processes by simultaneous measurements of thermal expansion and dielectric constant are described. (auth)

**28945** (USNRDL-TR-648) RADIOCHEMICAL SEPARADION OF CARRIER-FREE SILVER, CADMIUM, AND RHODIUM FROM EACH OTHER BY SOLVENT EXTRACTION. L. Wish and S. C. Foti (Naval Radiological Defense Lab., San Francisco). Apr. 28, 1963. 16p.

In some carrier-free radiochemical procedures for the analysis of fission products, the rhodium, silver, and cadmium radionuclides are separated by ion exchange. They are adsorbed preferentially on an anion column from weak hydrochloric acid solution. Most of the $Rh^{105}$ is eluted first, but since there is tailing, some rhodium will be found with the silver and cadmium fractions. In order to reduce this contamination, two reagents, triiso-octyl thiophosphate and triiso-octylamine, were tested as liquid extractants for the three elements. Partition coefficients were obtained and from these a method was developed for the individual separation of silver and of cadmium from rhodium. (auth)

**28946** (CEA-tr-A-1308) PROBLÈMES POSÉS PAR L'UTILISATION DE L'ÉNERGIE NUCLÉAIRE DANS L'INDUSTIRE CHIMIQUE. (Problems Posed by Utilization of Nuclear Energy in the Chemical Industry). H. Krauch. Translated from Chemiker Ztg, 84: 523-7(Aug. 20, 1960). 18p.

The uses of nuclear energy in chemical industries and the problems associated with these uses are outlined. The effects of hard radiations on matter, radiation effects on chemical reactions, and neutron activation are discussed. (T.F.H.)

**28947** (NP-tr-1035) THE RADIATION OXIDATION OF NITROGEN. I. KINETICS OF THE OXIDATION OF NITROGEN UNDER ELECTRON IMPACT AND ITS CONNECTION WITH IONISATION PROCESSES. M. T. Dmitriev and S. Ya. Pshezhetskii. Translated by E. F. Towndrow (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from p.145-70 of "Deistvie Ioniziruyushchikh Izluchenii na Neorganicheskie i Organicheskie Sistemy," Moscow, 1958. 58p. (Handwritten MS. copy)

An investigation was made of the kinetics of the oxidation of nitrogen caused by electron impact at electron energies from 0 to 400 ev and at pressures up to 0.1 mm Hg and also the ionization of nitrogen under the same conditions. The rate of the reaction has a maximum at an electron energy of 180 ev, which corresponds to the maximum for the ionization function of nitrogen. The ion yield of the reaction is about 2 and the activation energy is 7.4 kcal/M. The rate of the reaction is of second order. The rate constant of the reaction is proportional to the value of the electron current and the ionization function of nitrogen. The results show that the primary elementary process leading to the oxidation of nitrogen is the ionization of molecular nitrogen. No appreciable effect on the reaction was found from the primary ionization and excitation of oxygen. (N.W.R.)

**28948** (NP-tr-1036) THE RADIATION OXIDATION OF NITROGEN. II. KINETICS OF THE OXIDATION OF NITROGEN UNDER THE ACTION OF FAST ELECTRONS. M. T. Dmitriev and S. Ya. Pshezhetskii. Translated by E. F. Towndrow (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from p.171-81 of "Deistvie Ioniziruyushchikh Izluchenii na Neorganicheskie i Organichie Sistemy," Moscow, 1958. 31p. (Handwritten MS. copy)

The oxidation of nitrogen under the action of fast electrons in the gas phase was investigated at atmospheric pressure. The measurements were made by irradiating the gas above the surface of water, the nitrogen oxides dissolving in the water. The kinetics of the equation are represented by a second-order equation just as in the case of slow electrons and low pressures. The rate constant is proportional to the value of the electron current. The reaction takes place mainly by the absorption of radiation in the gas phase. The rate constant of the reaction is proportional to the ratio of the thickness of the gas layer to the maximum path of the electrons in the gas. At 40°C and atmospheric pressure the G-value is 1.3 atoms of combined nitrogen for air and 2 atoms for a 1:1 mixture per 100 ev of absorbed energy. The part played by nitrogen ions in the reaction is confirmed. An interpretation of the differences between the absolute values of the rate constant under the action of fast and slow electrons is given as being due to changes in the conditions of ion recombination. (N.W.R.)

**28949** OXY-REDUCTION OF THE $TcO_2 - TcO_4^-$ COUPLE IN DILUTED SOLUTION UNDER THE EFFECT OF GAMMA RAYS. Marc Lefort (Faculté des Sciences, Paris). Bull. Soc. Chim. France, No. 4, 882-4(Apr. 1963). (In French)

During the course of a study on the redox properties of Tc in aqueous solution, the absorption spectrum of the pertechnetate was defined. A method for the preparation of $TcO_2$ in alkaline solution by electrolysis was perfected. It was shown that ionizing radiations can not reduce the pertechnetate, but are capable of oxidizing the tetravalent Tc solutions with a yield G = 0.9. The oxide $TcO_2$ is very slightly soluble. Hydrogen peroxide accelerates the radio-induced oxidation and increases the yield to G = 8. (tr-auth)

**28950** DEVIATIONS FROM THE "MIXTURE LAW" IN THE RADIOLYSIS OF HYDROCARBON MIXTURES. II. YIELDS OF LIQUID PRODUCTS IN MIXTURES OF CYCLOHEXANE AND CYCLOPENTANE. P. J. Dyne and J. Denhartog (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 41: 1794-1800(July 1963).

The radiolytic yields of olefins and dimers were measured in mixtures of cyclohexane and cyclopentane. While the dimeric products ($(C_6H_{11})_2$, $C_6H_{11} \cdot C_5H_9$) show a bias towards $C_5$ groups, the olefins show a bias towards $C_6$ groups, the yield of cyclohexene at low concentrations of cyclohexane is more than twice the maximum predicted by the "mixture law." These results confirm earlier isotopic work which showed a higher reactivity of cyclohexane-$d_{12}$ in cyclohexane-$d_{12}$–cyclopentane mixtures relative to that in cyclohexane-$d_{12}$–cyclohexane. The results also confirm the preferential change of identity of cyclohexyl radicals to

cyclopentyl radicals, which leads to a predominance of $C_5$ groups in the dimer. (auth)

**28951** SOME PRODUCTS OF THE LIQUID PHASE RADIOLYSIS OF ACETONE. J. Kučera (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Collection Czech. Chem. Commun., 28: 1162-70(May 1963). (In English)

Irradiation of degassed liquid acetone with a $Co^{60}$ γ source (dose: $10^{20}$ to $10^{21}$ ev/ml) affords, in addition to the known gaseous products, a complex mixture of oxygen-containing, mostly liquid, products. Chromatographic analysis of this mixture showed the presence of formaldehyde, acetaldehyde, diacetyl, acetylacetone, acetonylacetone, methanol, ethanol, isopropanol, diacetone alcohol, pinacol, and acetic and oxalic acids, as well as several unidentified ketonic and hydroxylic substances. Small quantities of methyl ethyl ketone, methyl isobutyl ketone, mesityl oxide, phorone, ethylene glycol, 1,2-propanediol, and 2,3-butanediol may also be present. Possible reaction schemes leading to these products are proposed. (auth)

**28952** DETECTION OF β ACTIVITIES ON A THIN FILM CHROMATOGRAM WITH A GELATINIZED SCINTILLATOR. Jean-Claude Roucayrol and Pierre Taillandier (Faculté de Médecine, Paris). Compt. Rend., 256: 4653-4 (May 27, 1963). (In French)

In order to detect the β activities on a thin-film chromatogram, it is expedient to impregnate it with a gelatinized scintillator. The fluorescence photons are detected by a photomultiplier across a "slit" above which the glass support of the chromatogram is removed. (tr-auth)

**28953** ELECTRON PARAMAGNETIC RESONANCE OF IRRADIATED SODIUM NITRATE. Robert Adde and Pierre Petit (Institut d'Électronique, Orsay, France). Compt. Rend., 256: 4862-5(June 5, 1963). (In French)

Monocrystals of $NaNO_3$ were irradiated with 1.5-Mev electrons at doses between 10 and 250 Mrad. The EPR spectrum was studied at room temperature. The spectra obtained contain two groups. The first group, strongly anisotropic, is composed of three rays whose deviations vary as a function of the orientation. The second group has three rays of almost equal intensity (almost 10 to 20 times weaker than those of the first group) and the rays have only a slight anisotropy. The g and K tensors for the second spectrum were determined. The results are similar to those published previously on $NaNO_3$ irradiated with $Co^{60}$ γ rays and on the double nitrate of Mg and La containing radioactive isotopes. This similarity is an argument in favor of the Livingston and Zeldes interpretation (Nature, 179: 563(1957)) attributing this type of spectrum to $NO_2$ molecules. (J.S.R.)

**28954** CALORIMETRIC ANALYSIS OF THE RADIOPOLYMERIZATION OF SOLID ACRYLONITRILE. René Bensasson and Ary Dworkin (Faculté des Sciences, Paris). Compt. Rend., 256: 4903-6(June 5, 1963). (In French)

The reaction that takes place under irradiation can be distinguished from that that takes place after irradiation during reheating from the irradiation temperature up to the fusion temperature by the calorimetric study of the radiopolymerization of solid acrylonitrile. (tr-auth)

**28955** THE EFFECTS OF GAMMA AND ULTRAVIOLET IRRADIATION ON AQUEOUS SOLUTIONS OF THE TRIETHYLENEDIAMINE COMPLEX OF COBALT(III). L. N. Neokladnova and G. A. Shagisultanova. Dokl. Akad. Nauk SSSR, 149: 1084-7(Apr. 11, 1963). (In Russian)

Aqueous solutions of 0.01, 0.002, and 0.0001 mols/l of $[Co\ en_3]Cl_3$ were given a $Co^{60}$ dose of 2500 to 300,000 r in neutral, acid, and alkaline solutions. The changes due to irradiation were followed by taking absorption spectra in the visible and ultraviolet part of the spectrum, and by determining the increase in pH. In contrast to the behavior of $[Co(NH_3)_6]^{3+}$, a hydroxide precipitate did not form on irradiating $[Co\ en_3]^{3+}$, and the solution turned red. The radiolytic process was apparently reversible on acidifying (0.1N $HClO_4$) a solution given a dose of 20,000 r. This apparent reversibility was due to the formation of a diaquotetramine complex, whose absorption spectrum was the same as the spectrum of $[Co\ en_3]Cl_3$. Saturating the solution with hydrogen or oxygen had no effect on the absorption spectrum. It was suggested that an ethylenediamine group is split off from the complex by γ radiation or by ultraviolet light. Hydrogen ions reacted with the liberated ethylenediamine with the formation of a hydroxy complex and a resulting increase in the pH of the solution. (TTT)

**28956** THE RADIOLYSIS OF SULFURIC ACID. L. T. Bugaenko, Kuan-lin' Huan and N. A. Bakh (Moscow Univ.). Dokl. Akad. Nauk SSSR, 149: 1099-1102(Apr. 11, 1963). (In Russian)

Solutions of 0.4 to 18M $H_2SO_4$ were given a dose of $5 \times 10^{15}$ to $2 \times 10^{16}$ ev/ml-sec by 65-kev x rays, and $Co^{60}$ γ rays in the presence of ferrous sulfate. The concentrations of $Fe^{3+}$ and $SO_2$ were determined spectrophotometrically. The ratio of $G(Fe^{3+})_{O_2}$ to $G(Fe^{3+})_{N_2}$ decreased from 1.9 to 1.8 on increasing the concentration of $H_2SO_4$ from 0.4 to 17.3M. The yield of $SO_2$ was 0.61 molecules per 100 ev of absorbed energy, and did not depend on the presence or absence of oxygen. The yield for the decomposition of $H_2SO_4$ was equal to 4.15 molecules per 100 ev in 17.3M $H_2SO_4$. The mechanisms for the reaction for the irradiation of a dilute and a concentrated $H_2SO_4$ solution are discussed. (TTT)

**28957** THE RADIATION POLYMERIZATION OF TETRAFLUOROETHYLENE IN THE SOLID STATE. M. A. Bruk, A. D. Abkin, and P. M. Khomikovskii (Karpov Inst. of Physics and Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 149: 1322-5(Apr. 21, 1963). (In Russian)

Samples of pure tetrafluoroethylene (TFE) were frozen and irradiated with $Co^{60}$ γ rays and 1.5-Mev electrons. The yield of polymer was determined gravimetrically after rapid cooling of the irradiated samples. The electron paramagnetic resonance (EPR) spectrum was taken to determine the absolute concentration of radicals. The initial rate of polymerization of solid TFE, which was determined from the yield of polymer after the first 9 minutes of irradiation (0.05 to 0.8% conversion), increased with increasing temperature and reached a maximum near the melting point of the monomer. A decrease in the rate of polymerization of more than an order of magnitude took place on irradiating the monomer at the melting point. The activation energy for the solid-phase polymerization was 0.6 kcal/mole from −196 to −155°C and 1.6 kcal/mole from −155 to −131°C. The activation energy for the liquid-phase polymerization was 6 kcal/mole. The polymer yield for the solid-state irradiation was 100 molecules at −196°C and 1000 molecules per 100 ev at the melting point for conversions up to 1%. The yield of radicals at −196°C was ~0.4 per 100 ev for a dose of 5 to $10 \times 10^5$ rads. A sharp drop in the concentration of radicals took place in the temperature interval of −80 to −50°C and was accompanied by a change in the form of the EPR spectrum due to the build-up of a polymeric radical. A monomer radical was formed at low temperatures. (TTT)

**28958** THE MECHANISM OF THE RADIATION-INDUCED OXIDATION AND REDUCTION OF INORGANIC ACCEPTORS IN ACETONE SOLUTION. N. A. Bakh,

M. Roder, and L. T. Bugaenko (Moscow State Univ. and Inst. of Electrochemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 149: 1356-9(Apr. 21, 1963). (In Russian)

Acetone solutions of $10^{-5}$ to $10^{-2}$M in Fe(III), Fe(II), Cu(II), Cu(I), Cr(VI), Cr(III), Mn(VII), $I^-$, and $I_3^-$ were irradiated with x rays in sealed tubes under vacuum or in an atmosphere of nitrogen. Reduction of metals in the higher valence state was observed in all cases. Thus, the reduction yields for Cu(II), Fe(III), and Cr(VI) increased with increasing concentration, and attained values of 17.3, 14.5, and 10.5 equiv./100 ev respectively at $10^{-3}$ to $10^{-2}$M. The absence of a post-irradiation effect in the presence of excess acceptor indicated that the reaction is due to short-lived radiolysis products of acetone at $10^{-3}$ to $10^{-2}$M concentration of acceptor. On the other hand, the G value for the reduction of Mn(VII) was 20 equiv./100 ev with evidence of a significant post-radiation effect at a concentration of $2 \times 10^{-3}$M. On irradiating a 0.01M solution of KI in the absence of oxygen, iodine built up after the irradiation was stopped, and did not form during the irradiation. In the presence of oxygen, Cr(III) was oxidized to Cr(VI) with a G yield of 2 equiv./100 ev, and Cu(I) was oxidized to Cu(II) with a G yield of 30 equiv./100 ev due to reaction of Cu(I) with an intermediate oxyradical such as $RO_2^{\cdot}$ or with a peroxy compound such as ROOH. It is believed that excited acetone molecules participate in the reduction reaction. The yield of a product as a function of the concentration of the acceptor is given by the expression $1/G(\text{prod}) = (1/G_0)\,(A/t[\text{accept.}])$. $G_0$ is the yield of excited molecules found to equal ~23 excited molecules/100 ev for the reduction of Fe(III), Cu(II), and Mn(VII). The value of k is an indication of the activity of the acceptor, and was found to have a relative value of 2 for Fe(III), 2.5 for Cu(II), and 3.5 for Mn(VII). The high yields for these processes in acetone indicated that excitation energy is being transferred from acetone to the acceptor. (TTT)

**28959** A CHANGE IN LOCALIZATION OF AN UNPAIRED ELECTRON IN IRRADIATED PROTEINS SUBJECTED TO INFRARED IRRADIATION. M. K. Pulatova, E. A. Burshtein, and L. P. Kayushin (Inst. of Biological Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 149: 1432-4(Apr. 21, 1963). (In Russian)

The results of studies on the electron paramagnetic resonance (EPR) spectrum of irradiated proteins show that an unpaired electron is localized in some sort of trap in the irradiated protein molecule (super-fine splitting of the EPR signal), and that the multiplet form of the spectrum is due to the presence of cystine and cysteine in the irradiated molecule. If the electron could be liberated from the trap, the form of the EPR signal should become that of a singlet, and the intensity of the signal should decrease. To test this hypothesis, dried protein samples of pepsin, serum and egg albumin, dried rabbit muscle tissue, and denatured pepsin were subjected to a gamma radiation dose of 5 to 10 million r at room temperature in a vacuum of about $10^{-3}$ mm Hg std. The irradiated samples at room temperature gave a doublet EPR signal on a background of a "cysteine" multiplet structure. The shape of the spectrum did not change on cooling the irradiated samples to -196°C. On irradiating the irradiated samples with the light from a mercury vapor lamp in the region of 365 to 750 μ, no change in the EPR spectrum could be detected. On irradiating the irradiated protein samples with infrared light from a muffle furnace with a wavelength of 3.5 μ (energy of 0.34 ev) for 2 to 3 hours, the EPR doublet signal at liquid nitrogen temperatures was converted to a singlet having a total width less than the total width of the doublet. The "cysteine" background signal did not change. The pepsin denatured by boiling maintained the doublet form of the EPR spectrum. The infrared irradiation mobilized the trapped electron, and converted the free radical formed by irradiation to a chemically active form which could react with the surrounding molecules. (TTT)

**28960** THE ROLE OF THE CHEMIST IN NUCLEAR ENERGY. M. Zifferero (Univ. of Rome). Euratom Bull., No. 2, 26-30(June 1963). (In English)

The chemistry involved in the nuclear fuel cycle, improvements in fissile material production processes, fuel fabrication methods, post-irradiation processing techniques, and the treatment and disposal of waste is discussed. (C.E.S.)

**28961** RADIATION CHEMISTRY OF HYDROCARBONS. 6. SATURATED PRODUCTS IN HEXANE. Hans Widmer and Tino Gaeumann (Technische Hochschule, Zurich). Helv. Chim. Acta, 46: 944-54(1963). (In German)

The radiolysis of hexane in the temperature range -196 to +150°C was examined. The yields of nearly all saturated products that are formed at low doses were determined. A hypothetical distribution of free radicals was calculated. Although the qualitative behavior of this distribution fits the expected temperature dependence, reasons are put forward to explain that beside the radical reactions other mechanisms must occur that give the same products. (auth)

**28962** FRAGMENTATION OF TETRABORANE BY ELECTRON IMPACT. T. P. Fehlner and W. S. Koski (Johns Hopkins Univ., Baltimore). J. Am. Chem. Soc., 85: 1905-9(July 5, 1963).

The fragmentation of the isotopically labeled tetraboranes $B^{11}{}_4H_{10}$, $B^{11}{}_4D_{10}$, and $B_4H_8D_2$ by electron impact was studied. A preferred path of decomposition and structures of the fragment ions are proposed from the observed fragmentation patterns and the numerous metastable transitions. Using these structures and the measured appearance potentials of selected fragments, ionization potentials are calculated. Metastable transitions involving the loss of 3H or 3D, not found in hydrocarbon mass spectra, are observed. (auth)

**28963** ELECTRON SPIN RESONANCE IN A GAMMA-IRRADIATED SINGLE CRYSTAL OF MERCAPTOSUCCINIC ACID. Yu Hak Hahn and H. N. Rexroad (West Virginia Univ., Morgantown, W. Va.). J. Chem. Phys., 38: 1599-1602(Apr. 1, 1963).

The four most intense resonances in the ESR spectrum of a γ-irradiated single crystal of mercaptosuccinic acid are shown to be due to the same free radical which has four different orientations in the crystal. By analysis of the anisotropy in the spectroscopic splitting factor the principal values of the g tensor were found to be 2.003, 2.026, and 2.054. It is believed that the free radical $HOOC-CH_2-HCS-COOH$ is responsible for the observed resonance. The model of Kurita and Gordy in which the electron spin density is concentrated in a nonbonding 3p orbital of the sulfur atom successfully accounts for the basic features of the anisotropy of the g tensor. (auth)

**28964** MASS SPECTROMETRIC ANALYSES OF THE IONS RESULTING FROM THE NUCLEAR DECAY OF $CH_3I^{130}$ AND $C_2H_5I^{131}$. STUDY OF XENON-HYDROCARBON IONS. [PART] II. Thomas A. Carlson and R. Milford White (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 38: 2075-81(May 1, 1963).

Ions resulting from the nuclear decay of $CH_3I^{130}$ and $C_2H_5I^{131}$ were measured with a specially designed mass

spectrometer. From these two studies the percent abundances for the parent ions, $[CH_3Xe^{130}I]^+$ and $[C_2H_5Xe^{131}]^+$, are found to be, respectively, 34% and 1.4%. Besides $CH_3^+$ and $C_2H_5^+$, formed directly from the severance of the C–Xe bond of the parent ions, a large variety of fragment ions are also observed. The results are compared with those for a similar study on $CH_3I^{131}$. From these comparisons the following conclusions are reached: (1) the ethyl-xenon ion undergoes decomposition much more readily than the methyl–xenon ion, and (2) the greater recoil energy that is present in the decay of $I^{130}$ leads primarily to the severance of the organic–zenon bond, with the formation of $CH_3^+$. Besides recoil energy, there are also two other sources of excitation: (1) Coulombic shaking, as the result of the sudden change in nuclear charge following beta decay, is used to explain the appearance of the lower-charged Xe ions and most of the fragment hydrocarbon ions. (2) Multiple Auger processes following internal conversion are given as the cause for the more highly charged Xe ions, and their abundance is correlated with the amount of internal conversion present in $I^{130}$ and $I^{131}$. (auth)

**28965** PARAMAGNETIC RESONANCE SPECTRUM OF IRRADIATED GLYCYLGLYCINE HCl. Harold C. Box, Harold G. Freund, and K. T. Lilga (Roswell Park Memorial Inst., Buffalo). J. Chem. Phys., 38: 2100-4(May 1, 1963).

Electron spin resonance measurements on irradiated single crystals of glycylglycine hydrochloride show that the free radical $ClNH_3–CH_2–CONH–CH–COOH$ is formed. The protons attached to the alpha carbon atom and to the amide nitrogen atom contribute to the hyperfine structure. The ESR spectrum correlates well with the structure of the undamaged crystal. (auth)

**28966** RADIOLYSIS OF METHANE. P. J. Ausloos and S. G. Lias (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 38: 2207-14(May 1, 1963).

The radiolysis of $CD_4$, as well as of equimolar $CH_4 + CD_4$ mixtures, was investigated in the presence of $C_3H_8$, $C_4H_{10}$, $C_6H_6$, $C_2H_4$, argon, krypton, and xenon. The results obtained from the radiolysis of $CD_4–C_3H_8–I_2$ and $CD_4–C_4H_{10}–I_2$ mixtures indicate that ethyl ions and sec-propyl ions are produced. ($G_{C_3D_8^+} \geq 1.0$, $G_{sec\text{-}C_3D_7^+} \geq 0.06$.) The radiolysis of methane in the presence of $C_2H_4$ and $C_6H_6$ provided evidence for the occurrence of the process: $CH_4^* \rightarrow CH_2 + H_2$. The G value of this process is approximately equal to unity. An analysis of the ethanes produced in the radiolysis of equimolar $CH_4–CD_4$ mixtures in the presence and absence of ethylene provided evidence for the production of methylene radicals in both the gas phase and the liquid phase. (auth)

**28967** EPR SPECTRUM OF IRRADIATED ORIENTED POLYTETRAFLUOROETHYLENE. D. W. Ovenall (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.). J. Chem. Phys., 38: 2448-54(May 15, 1963).

The electron paramagnetic resonance (EPR) spectra of free radicals trapped in oriented samples of polytetrafluoroethylene, after high-energy irradiation in vacuum, are dependent on the angle between the orientation direction and the direction of the magnetic field applied in the EPR experiment. This orientation dependence is considered in the light of recently published data on fluorine-containing free radicals trapped in irradiated single crystals of fluorocarbon compounds. The radical $–CF_2–CF–CF_2–$ put forward to account for the EPR spectra of randomly oriented samples of irradiated polytetrafluoroethylene provides a satisfactory explanation of the principal features of the spectra and their orientation dependence. Several additional weak hyperfine lines were observed and possible origins of these are discussed. (auth)

**28968** RADIOLYSIS OF PROPANE-$d_8$ IN THE PRESENCE OF ORGANIC COMPOUNDS OTHER THAN HYDROCARBONS. I. B. Sandoval and P. J. Ausloos (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 38: 2454-60(May 15, 1963).

The gas phase radiolysis of propane-$d_8$ was investigated in the presence of dimethylmercury, azomethane, acetone, methyliodide, methanol, nitromethane, and methylamine. The cross section of the hydride-transfer reaction $C_2D_5^+ + RH \rightarrow C_2D_5H + R^+$ is, in all cases, at least 10 times smaller than that of the reaction $C_2D_5^+ + C_3D_8 \rightarrow C_2D_6 + C_3D_7^+$. Evidence for the occurrence of the proton-transfer reaction $C_2D_5^+ + RH \rightarrow C_2D_4 + RHD^+$ was obtained. For the mixtures containing methanol, the cross section of this proton-transfer reaction is about 50 times that of the hydride-transfer process. Approximate values of $G(CH_3^+)$ were determined for most of the additives. (auth)

**28969** ATOMIC AND IONIC RECOIL FROM THE (n,γ) REACTION. Joseph L. Thompson and Warren W. Miller (Pennsylvania State Univ., University Park). J. Chem. Phys., 38: 2477-9(May 15, 1963).

The occurrence of charge on the recoil atoms produced by the (n,γ) reaction was examined for several elements and for different chemical states of the same element. The fraction of the recoil atoms leaving a substrate and crossing a potential gap that carries a positive charge was determined by observing the ratio of the atoms on charged and uncharged collector cylinders. The fractions of positively charged recoils are, for In, 0.46; $In_2S_3$, 0.50; $In_2O_3$, 0.55; $InF_3$, 0.40; Mn, 0.52; $KMnO_4$, 0.56; $Dy_2O_3$, 0.63. From considerations of the capture gamma-ray-decay schemes and lifetimes of states giving rise to transitions by conversion electron it appears that, in a condensed medium, the recoiling atom rarely develops a charge prior to the loss of its initial kinetic energy. (auth)

**28970** PHOTOINDUCED PARAMAGNETISM IN SOLUTIONS OF NITROBENZENE IN TETRAHYDROFURAN. Raymond L. Ward (Univ. of California, Livermore). J. Chem. Phys., 38: 2588-9(May 15, 1963). (UCRL-7135-T)

ESR studies are reported of photoinduced paramagnetism in solutions of nitrobenzene in undeuterated and deuterated tetrahydrofuran (THF). The ESR spectrum exhibits a widely spaced set of identical triplets, and the extra proton hyperfine interaction ($0.38 \pm 0.04$ Oe) is due to a single α proton of the THF molecule. The experiments of Lagercrantz and Yhland with trinitrobenzene were also repeated, and the following mechanism for the production of the paramagnetic species is proposed: Light irradiation causes the nitro group to abstract an α hydrogen atom from the THF molecule, and the resulting THF free radicals rapidly dimerize or disproportionate, leaving a neutral nitrobenzene free radical in solution. The radical has a total decay time of ~ 2 sec and is suspected to reside on an oxygen atom. (D.L.C.)

**28971** DISTRIBUTION OF RADIOACTIVE ANTIMONY FORMED BY NEUTRON CAPTURE IN ANTIMONY COMPOUNDS. J. F. Facetti (Puerto Rico Nuclear Centre, Mayaguez). J. Inorg. Nucl. Chem., 25: 759-62(July 1963). (In English)

Antimony compounds were irradiated with neutrons and the distribution of radioactive $Sb^{122}$ and $Sb^{124}$ between the tri- and pentavalent oxidation states determined, after dissolving the samples in either fused potassium hydroxide or concentrated hydrochloric acid. The results suggest that the new species reach their final oxidation state in the crystal, either during, or a short time after, irradiation. In addition, the results show a linear relation between the

composition of the oxide and the percentage of radioactive Sb(v) similar to that obtained by other workers with arsenic oxides. (auth)

**28972** THE PREPARATION OF RADIOACTIVE D-GALACTOSE FROM RADIOACTIVE D-GLUCOSE. Bernice D. Kohn and Paul Kohn (Argonne National Lab., Ill. and Univ. of Illinois Coll. of Medicine, Chicago). J. Org. Chem., 28: 1037-41(Apr. 1963). (TID-17448; UAC-6905)

D-Galactose-U-$C^{14}$,4-T was prepared from D-glucose-U-$C^{14}$ by conversion to 2,3:5,6-di-O-isopropylidene D-glucose-U-$C^{14}$ dimethyl acetal. The substance was oxidized to di-O-isopropylidene-4-keto D-glucose-U-$C^{14}$ dimethyl acetal, which was subsequently reduced with lithium aluminum tritide, yielding the corresponding galactose and glucose derivatives from which the free sugars were obtained after hydrolysis. (auth)

**28973** METHOD OF PREPARATION OF SOLUBLE RADIOPHOSPHATE. C. T. Peng (Univ. of California, San Francisco). J. Pharm. Sci., 51: 293(Mar. 1962).

Soluble radiophosphate was prepared from unsatisfactory preparations by passing a 0.1N HCl solution of phosphate through a Dowex 50-X8, 100-200 mesh resin column (H form, 1 × 15 cm) at a flow rate of ~2 ml/min. After the effluent is evaporated to dryness on a water bath, the residue is present as phosphoric acid in trace amounts. It is taken up in isotonic saline and the solution filtered to give the soluble radiophosphate. Extensive conditioning of the cation exchange resin is essential for the success of the procedure; this can be done with alternate N HCl and N NaOH washes, followed by exhaustive extraction with 95% ethanol to remove any organic impurities. To minimize radiation damage to the resin, the carrier-free radiophosphate solution is diluted to give an activity of approximately 1 mC/ml for passage through the column. The resin column is washed with 0.1N HCl after use and stored. The overall loss of radioactivity due to manipulation is negligible. (TCO)

**28974** EFFECTS OF IONIZING RADIATION ON TWO GELATIN FRACTIONS. I. MATERIAL PREPARATION, DOSIMETRY, AND ACID-BASE BEHAVIOR. Leonard P. Prusak and Bartley J. Sciarrone (Johnson & Johnson, New Brunswick, N. J.). J. Pharm. Sci., 51: 1046-50(Nov. 1962).

Pigskin gelatin was separated into 2 fractions, F-I and F-II, by low-temperature alcohol precipitation. Both fractions, in 1 and 5% solutions and as films, were exposed to electron-beam irradiation at 3-Mev to give absorbed-dose values of from about 0.1 to about 3 Mrad. Radiation dose was determined by means of Ce(IV)–Ce(III) and polyvinyl chloride dosimetry. Preliminary tests on 1% solutions and 5% gels indicated upper tolerances of energy at about 2.5–3.0 Mrad for F-I and about 2.0 Mrad for F-II to avoid visible denaturation. When the dose limits for F-I and F-II were exceeded, both the 1% solutions and the 5% gels showed cloudiness. The 5% gel also became extremely viscous. Acid-base titration curves on the commercial gelatin sample, control fractions F-I and F-II, and irradiated F-I and F-II, as 1% and 5% solutions and as films, all showed differences in COOH and $NH_2$ content. The curves showed pronounced alterations over the pH range 5–10. Irradiation of the 2 gelatin fractions as 1% solutions did not materially affect either their acid-binding or base-binding capacity at the distal ends of the titration curves. In the region of neutrality, and 2 pH units on either side of it, a substantial variance occurred at the lowest irradiation level, which gradually lessened as the dose increased. F-II required acid/base milliequivalents of constant value in this region whereas F-I initially (0.37 Mrad) bound 0.12 milliequivalents of base. (TCO)

**28975** THE EFFECT OF BENZENE MODERATOR ON THE (n,γ) ACTIVATED REACTIONS OF BROMINE ATOMS WITH ETHYL BROMIDE. Miriam Milman (Ecole Normale Superieure, Orsay, France). J. Phys. Chem., 67: 537-40 (Mar. 1963).

The nature of the chemical reactions following neutron capture in mixtures of ethyl bromide and benzene were studied. After having ascertained the own reactivity of the benzene moderator, it was possible to determine the contribution of "hot" and "diffusive" reactions to the yield of organic activity. A tentative description of the nature of reactions following radiative neutron capture in the solid system is proposed. (auth)

**28976** FREE RADICAL REACTIONS INITIATED BY IONIZING RADIATIONS. III. PARAFFIN REACTIVITIES IN HYDROGEN ATOM ABSTRACTION REACTIONS. Kang Yang (Continental Oil Co., Ponca City, Okla.). J. Phys. Chem., 67: 562-6(Mar. 1963).

Rate constants, $k = BT^{\eta} \exp(-\epsilon/RT)$, for these reactions $H + M \rightarrow H_2 + R$ were determined by investigating the temperature dependence of hydrogen yields in the γ-radiolysis of paraffin–propylene systems. Assuming $\epsilon = 2.2$ kcal/mole for the hydrogen atom addition reaction with propylene, the following ε values are estimated: ethane, 8.6; propane, 7.0; n-butane, 6.3; isobutane, 4.7. The LCBO treatment of an assumption that the energy required for isolating two electrons in a bond to be broken from the rest of the σ-electron system plays the decisive role in determining paraffin reactivities leads to the expression: $\epsilon = \xi + N_{CH}\eta$. Here $N_{CH}$ is the number of additional CH bonds formed by the carbon atom that forms the CH bond to be broken. Two constants, ξ and η, have these meanings: ξ is the activation energy for the hydrogen atom abstraction reaction involving diatomic CH molecules; and η represents the major structural contribution to the reactivity and comes comes from the fact that the bond to be broken undergoes stabilizing interactions with neighboring CH bonds. Examination of experimental data in the light of the above equation indicates that each such interaction contributes 2.0 kcal/mole to the activation energy, thus reducing the paraffin reactivity about 30-fold at room temperature. (auth)

**28977** THE LIQUID PHASE REACTION OF METHYL RADICALS WITH METHANOL. Mark Cher (Atomics International, Canoga Park, Calif.). J. Phys. Chem., 67: 605-7(Mar. 1963).

The liquid phase photolysis ($\lambda > 2900$ Å) of acetone-$d_6$ in the presence of $CH_3OH$ and $CD_3OH$ was studied at 30.0° by measuring the isotopic composition of the resulting methanes. The results are interpreted in terms of hydrogen abstraction reactions of methyl-$d_3$ radicals with substrate molecules. The conclusions are: the rate constant for the abstraction of hydrogen from the methyl group in methanol is (a) 45 times greater than the rate constant for the abstraction of hydrogen from the hydroxyl group in methanol, (b) 8.7 times greater than the rate constant for the abstraction of deuterium from $CD_3OH$, and (c) 0.56 times as large as the rate constant for the abstraction of deuterium from acetone-$d_6$. The disproportionation reaction between methyl and acetyl radicals to form methane and ketene is shown to be unimportant except at light intensities much higher than that used in the measurements. (auth)

**28978** CARBON-14-CONTAINING COMPOUNDS PRODUCED BY THE PILE NEUTRON IRRADIATION OF α-CYANOACETAMIDE. Thomas W. Lapp and Robert W.

Kiser (Kansas State Univ., Manhattan). J. Phys. Chem., 67: 612-15(Mar. 1963).

An investigation was conducted of the nature and relative quantities of the radiocarbon-labelled compounds obtained from the dissolution of water of pile-neutron irradiated α-cyanoacetamide. Succinamide and α-cyanoacetamide were found to contain 23 and 9%, respectively, of the total carbon-14 activity induced in the α-cyanoacetamide sample. A polymeric material, $(>CHC(O)NH-)_x$, was found to contain 44% of the total carbon-14 activity. Little activity was found in twelve other chemical species investigated. Possible paths are suggested leading from the matrix-stabilized species to the final products observed in solution. (auth)

**28979** THE RADIATION CHEMISTRY OF SOME OF THE HIGHER ALIPHATIC ALCOHOLS—FURTHER STUDIES ON RADICALS TRAPPED AT LOW TEMPERATURES. Russell H. Johnsen and D. A. Becker (Florida State Univ., Tallahassee). J. Phys. Chem., 67: 831-5 (Apr. 1963).

The radiation chemistry of isopropyl alcohol, 1-butanol, sec-butyl alcohol, and t-butyl alcohol was investigated in both liquid and solid states. The effect of bleaching with visible and ultraviolet light on free radicals trapped in the low-temperature alcohol samples was studied. The results of these experiments were interpreted in terms of ionic and free radical reactions and applied to the problem of alcohol radiation chemistry in general. (auth)

**28980** RADIOLYSIS PRODUCTS OF $C_8$ AND GREATER CARBON CONTENT FROM 2,2,4-TRIMETHYLPENTANE. J. A. Knight, R. L. McDaniel, and Fred Sicilio (Georgia Inst. of Tech., Atlanta). J. Phys. Chem., 67: 921-3(Apr. 1963).

Results are reported for gas chromatographic studies of radiolysis products $C_8$ and greater from the x-irradiation of 2,2,4-trimethylpentane. The $C_8$ and $C_9$ products with a total G value of 0.53 could be identified individually and are tabulated. The $C_{11}$ to $C_{16}$ products were at least 24 in number and had a total G value of 1.15. The residual radiolysis product apparently was $C_{12}$ to $C_{16}$. The unsaturation in the products was also studied. It is suggested that the largest molecular products are due to dimerization of two $C_8$ components. (D.L.C.)

**28981** ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED SINGLE CRYSTALS OF D-FRUCTOSE AND L-SORBOSE. Hisashi Ueda (Duke Univ., Durham, N. C.). J. Phys. Chem., 67: 966-8(May 1963).

Among the polycrystalline sugars, only D-fructose and L-sorbose, when irradiated, are known to give a esr spectrum of four lines. When irradiated polycrystalline L-sorbose was heated to 100°, it gave a spectrum identical with that of irradiated D-fructose, which had not been heated. The results obtained from polycrystalline materials were studied in detail using single crystals. Irradiation at 77°K followed by heating revealed that a radical transformation occurs in the sugars, which is caused by the deformation of the pyranose ring. The free radical produced is $-CH(OH)-\dot{C}(OH)-CH_2-O-$. (auth)

**28982** RECOIL PARTICLE LOSS IN HOT ATOM CHEMISTRY EXPERIMENTS; THE DISTRIBUTION OF PATH LENGTHS IN A RIGHT CIRCULAR CYLINDER. William J. Argersinger, Jr. (Univ. of Kansas, Lawrence). J. Phys. Chem., 67: 976-9(May 1963).

The geometrical problem of the distribution of distances from random sources to the wall in a right circular cylinder is completely solved. The distribution function is used to determine the recoil loss in hot atom chemistry experiments. The cylinder shape for minimum recoil loss is determined for conditions of fixed sample volume and particle range; the recoil loss is compared with that for a spherical sample. (auth)

**28983** RADIATION INDUCED POLYMERIZATION OF PROPYLENE AT HIGH PRESSURE. Daniel W. Brown and Leo A. Wall (National Bureau of Standards, Washington, D. C.). J. Phys. Chem., 67: 1016-19(May 1963).

The polymerization of propylene was investigated at temperatures of 21, 48, and 83°, and at pressures between 5000 and 16000 atmospheres. The effect of reaction conditions on the rate of polymerization and the molecular weight suggests that the polymerization proceeds by a radical mechanism with a large monomer transfer constant. The degree of polymerization was equal to the ratio of propagation rate to transfer rate. It varied from 25 to 75, decreasing with temperature increases or pressure decreases. The rate of polymerization increased by a factor of 100 at room temperature between pressures of 5000 and 16000 atmospheres. The activation energy was 8 kcal/mole at 5000 and 12000 atmospheres pressure. (auth)

**28984** DECOMPOSITION OF CRYSTALLINE NITRATES BY LIGHT IONS AT KILOVOLT ENERGIES. S. R. Logan and Walter J. Moore (Indiana Univ., Bloomington). J. Phys. Chem., 67: 1042-8(May 1963).

Electromagnetically analyzed ionic beams of about 10 microamp $cm^{-2}$ from a radiofrequency source were allowed to impinge on targets of polycrystalline alkali metal nitrates. The ions used were $D^+$, $He^+$, and $D_3^+$, at energies from 2 to 16 kev. At these energies the incident particles and primary knock-ons give reactions typical of hot atoms rather than those associated with extensive electronic excitation. The reaction $NO_3^- \rightarrow NO_2^- + \frac{1}{2}O_2$ proceeded cleanly and was followed by spectrophotometric analyses of the bombarded targets. At constant energy and beam intensity, the yield with respect to dose was approximately first order in undecomposed nitrate. A typical initial $G(NO_2^-)$ value was 1.54 for 10 kev $He^+$ ions on $KNO_3$. Relative to K = 1.00, the yields were Li = 0.26, Na = 0.61, Rb = 0.58, Cs = 0.67. The yield from $KNO_3$ decreased with rise in T from 100 to 273°K and then rose from 273 to 420°K. The initial yields were analyzed by a Monte Carlo computation in terms of a model based on hard sphere collisions of the fast incoming ion with atoms in the nitrate, and similar collisions of knock-out oxygen atoms in spurs along the track of the incoming particle. The model provided fairly good agreement with experiments on energy dependence of initial yield. An explanation of relative yields of the different nitrates would require an extension of the model to include structure specific energy losses to vibrational modes of the crystals. (auth)

**28985** THEORY OF RADIATION CHEMISTRY. VI. CYLINDRICAL DIFFUSION MODEL WITH A SCAVENGER. Aryeh H. Samuel and James S. Mills (Stanford Research Inst., Menlo Park, Calif.). J. Phys. Chem., 67: 1155-7 (May 1963).

A cylindrical model for irradiations with particles of high linear energy transfer (LET) was modified by the introduction of a homogeneously distributed scavenger (solute) that ultimately reacts with all active species that do not undergo pairwise recombination. The scavenger is assumed to be present in constant concentration $c_s$. A procedure is outlined primarily for the study of gases. It was found that for all types of radiation, it is possible to vary the scavenger, $F_s$, by changing a number of parameters.

$F_2$ can also be changed if only the pressure is varied. Preliminary calculations indicate that this effect may be important in the design of fissiochemical reactor. (P.C.H.)

**28986** X-RAY INDUCED PARTICLE SIZE CHANGES IN THALLOUS AZIDE. Brigitte H. Krause (U. S. Army Engineer Research and Development Labs., Fort Belvoir, Va.). J. Phys. Chem. Solids, 24: 779-80(June 1963). (In English)

Some of the x-ray diffraction lines of x-irradiated inorganic azide powder samples are both shifted and broadened. In order to determine the cause of the broadening, the (002) reflection of x-irradiated $TlN_3$ powder samples were analyzed in terms of Fourier coefficients. The results indicate that the line broadening does not start at the onset of irradiation but after ~2 hr, and that the Fourier coefficients decrease linearly with the logarithm of irradiation time between 2 and 30 hr. The particle size change with irradiation is also calculated, and it is concluded that particle size changes are the main cause of the line broadening. Since the rate of lattice constant change is highest at the beginning of irradiation where no line broadening occurs, line shifts and line broadening are caused by different processes. (D.L.C.)

**28987** SYNTHESIS OF STYRENE-METHYL METHACRYLATE NONRANDOM COPOLYMERS IN EMULSION SYSTEMS WITH COBALT-60 GAMMA RADIATION. G. J. K. Acres and F. L. Dalton (Wantage Research Lab., Berks, Eng.). J. Polymer Sci., Pt. A, 1: 2419-38(July 1963).

Graft copolymers were prepared by the irradiation of polymer lattices swollen with monomer. The lattices used were prepared by radiation polymerization of emulsions to avoid the presence of initiator molecules in the second stage. Lattices of polystyrene swollen with methyl methacrylate and polymethyl methacrylate swollen with styrene were used. Polymerizations were followed dilatometrically and the dependence of polymerization rate on monomer concentration and radiation intensity obtained for both systems studied. Separation of copolymer from homopolymers was attempted by thermal gradient elution chromatography; the method proved satisfactory when the solvent–nonsolvent system benzene–petroleum ether was used, but failed to give separations when benzene–methanol was used. This failure is thought to be due to cosolution phenomena. (auth)

**28988** RADIATION INDUCED SOLID STATE COPOLYMERIZATION OF OXETANES. K. Hayashi, H. Watanabe, and S. Okamura (Japanese Assn. for Radiation Research on Polymers, Osaka). J. Polymer Sci., Pt. B, 1: 397-401 (July 1963).

The following four oxetanes were synthesized and copolymerized with each other by gamma radiation: 3,3-bis(chloromethyl)oxetane (BCMO), 3-ethyl-3-chloromethyloxetane (ECMO), 3,3-bis(bromomethyl)oxetane (BBMO), and 3-ethyl-3-bromomethyloxetane (EBMO). Melting point measurements, differential thermal analysis, and x-ray diffraction analysis were carried out on monomer mixtures and copolymers for the following combinations: BCMO-BBMO, BCMO-ECMO, ECMO-EBMO, BBMO-EBMO. Yields and compositions of the copolymers are plotted against mole fraction in monomer. (D.L.C.)

**28989** RADIATION-INDUCED COPOLYMERIZATION OF ACRYLONITRILE AND METHYL METHACRYLATE. Hiroshi Sobue, Yoneho Tabata, and Yoshio Hashizume (Japanese Assn. for Radiation Research on Polymers, Tokyo). Kogyo Kagaku Zasshi, 65: 1886-8(Nov. 1962).

Copolymerization of acrylonitrile (AN) and methyl methacrylate (MMA) induced by ionizing radiation was investigated in bulk. Variables studied were: the dependence of the copolymerization rate on dose rate, polymerization at various temperatures. The copolymerization rate was proportional to the square root of dose rate in a molar equivalent mixture of monomers at room temperature. The apparent activation energy of the copolymerization was 4.62 kcal/mole in a molar equivalent mixture of the monomers. The copolymerization rate increased with a decrease of the mole fraction of AN in the monomer mixture at room temperature, while at –78°C, maximum rate of copolymerization was observed in the mole fraction of AN of 0.75. It was concluded from the composition curves of copolymerization that the copolymerization probably proceeded by a radical mechanism in the range from 52.5 to –20°C and by both anionic and radical mechanisms at around –78°C. (H.H.D.)

**28990** A CONTINUOUS ELECTROCHEMICAL PROCESS FOR THE SEPARATION OF CARRIER-FREE RADIOACTIVE ISOTOPES. Józef Molnár. Magy. Kem. Folyoirat, No. 11, 504-10(1962).

A new continuous electrolysis apparatus, which differs from the older types particularly in the design of its cathode, is described. A cathode arrangement of small Pt chips placed in a glass tube is suggested, through which the electrolyte is passed in a continuous flow. An anode of area 2–3 times smaller than the cathode was found to be sufficient in the arrangement, when larger voltages were applied. In the course of designing the apparatus, a 1 × 1 cm cross section cell was constructed, with a cathode system of fifty 1.1 × 1.2 cm lt grids, with 220 holes/$cm^2$, connected in series, and was used to investigate the polarization behavior of such electrode systems. The polarization of individual grids was measured in solutions of various conductances. In the case of cathodic polarization relative to the anode, the potentials of the grids relative to the solution were not equal to each other. The greater the difference of polarization between the various grids, the higher the polarizing voltage or current intensity, and the smaller the conductance of the solution. Polarization reaches a limiting value when the voltage is increased. The new apparatus may be used for either rapid separation of carrier-free radioactive isotopes, or removal of traces of heavy metals from aqueous solutions. (OTS)

**28991** MOLECULAR WEIGHT DISTRIBUTION CHANGES IN POLYMERS ON IRRADIATION. M. A. Crook and F. S. Walker (British Insulated Callender's Cables, Ltd., London). Nature, 198: 1163-5(June 22, 1963).

Gradient elution fractionation and viscosity measurements were used to study changes in the molecular weight distribution in irradiated polyvinyl chloride. The polymer was irradiated with either 6 Mrad of $Co^{60}$ γ rays in vacuum or 6 Mrad of 2-Mev electrons in air. The molecular weight distribution curve of vacuum-irradiated polymer showed some crosslinking but no degradation, while that for air-irradiated polymer showed extensive degradation. Attempts were made to fit statistical theories to the curves, and it is concluded that the crosslinking process obeys a simple statistical theory while the degradation process does not obey any such simple idea. (D.L.C.)

**28992** FORMATION OF ADENOSINE BY ULTRAVIOLET IRRADIATION OF A SOLUTION OF ADENINE AND RIBOSE. Cyril Ponnamperuma (Ames Research Center, Moffett Field, Calif.); Ruth Mariner, and Carl Sagan. Nature, 198: 1199-1200(June 22, 1963).

In a study of possible origins of life, mixtures of

adenine-8-$C^{14}$ and ribose were irradiated in the air-free state by ultraviolet germicidal lamps for 1 hr (~$10^8$ ergs absorbed) and then chromatographed and autoradiographed for evidence of adenosine formation. No adenosine was detected for adenine and ribose alone, but when phosphoric acid or ethyl metaphosphate was added, adenosine was formed in a yield of ~0.01% (quantum yield ~$10^{-5}$). The yield was not affected by hydrogen or air in the atmosphere above the solution, or the pH. (D.L.C.)

**28993** γ-RADIATION-THERMAL CRACKING OF HYDROCARBONS. A. V. Topchiev, L. S. Polak, and V. D. Timofeev. Neftekhimiya, 3: 114-23(Jan.-Feb. 1963).

The effect of 1 to 30 atm pressure on the radiation-thermal cracking (RTC) of gasoline (bp ≤ 140°C) and gas oil ($n_D^{20}$, 1.4740; sulfonatable hydrocarbons, 24%; bromine number, 3.2) in uniform temperature and γ-radiation-dose fields was studied. Experiments were conducted in a flow reactor at 450 to 600°C with radiation exposure times of 6.85 sec (at 600°C and 1 atm) to 452 sec (at 450°C and 30 atm) at a dose rate of $2.6 \cdot 10^{14} \pm 10\%$ ev/sec/ml of vapors (STP). Thermal-cracking (TC) control experiments were conducted under similar conditions. The results of the study, given in the form of graphs and tables, show that an increase in pressure increases the yield of gaseous RTC products at 450 to 500°C, but decreases the yield slightly at 550 to 600°C. The rate of formation of the products drops with a 1- to 5-atm pressure rise and remains unchanged (gasoline) or increases (gas oil) with any further increase in pressure. In the given conditions, the yields of gaseous products, in particular those of olefins, are higher in RTC than in TC. The radiation yields increase with temperature but drop, as a rule, with increasing pressure. (OTS)

**28994** ON THE PREPARATION OF $Tc^{99}$ FOR MEDICAL PURPOSES. K. E. Scheer and W. Maier-Borst (Universität, Heidelberg). Nucl. Med., 3: 214-17(1963). (In German)

The production of $Tc^{99m}$ by separation from $Mo^{99}$ is reported. The chromatographic separation from neutron-irradiated molybdenum gives a better yield than the distillation as $HTcO_4$, but requires more time. The physiological behavior of Tc is reported. (auth)

**28995** QUENCHING OF LUMINESCENCE IN ACTIVATED ZnS-POWDERS IRRADIATED IN ATOMIC PILE. P. Jaszczyn (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Phys. Status Solidi, 3: K211-17 (1963). (In English)

Studies were made of the relation between the luminescent and the quenching characteristics of ZnS samples and their resistance to radiation damage. The influence of Cu and Co on the generation of quenching centers by pile irradiation was determined. The phosphors were bombarded with a neutron flux of $2 \times 10^{13}$ $ncm^{-2}sec^{-1}$. The blue luminescence was excited by a light source. The data proved that pile irradiation increased the thermal quenching in activated ZnS much less than in unactivated ZnS. Copper introduced green luminescent centers to which the holes released from excited blue centers may be partially transferred. ZnS powder containing a small number of quenching centers appeared to be relatively resistant to radiation damage. (M.C.G.)

**28996** RADIATION-INDUCED CHLOROSULFONYLATION OF POLY(DIMETHYLSILOXANES). R. V. Dzhagatspanyan, V. I. Zetkin, V. E. Pospolov, and V. S. Fedchenko. Plasticheskie Massy, No. 2, 16-18(1963).

The γ radioinduced chlorosulfonylation of poly(dimethylsiloxane) rubber with a mixture of $SO_2$ and $Cl_2$ was carried out. It is expected that chlorosulfonylated will exhibit a number of interesting properties and, in particular, will be readily vulcanizable. It is also expected that the adhesive properties can be improved by the substitution of polar and nonpolar functional groups. The sample (molecular weight = 500000) was chlorosulfonylated at 0 to 60°C with a dried 2.69 to 0.46 : 1 $SO_2/Cl_2$ mixture in $CCl_4$ solution γ irradiated from a $Co^{60}$ source. The radiation dose used was substantially below that which would produce noticeable cross-linking in the rubber. It was found that: the rate of chlorosulfonylation and chlorination is at a maximum at 40°C; at a $SO_2-Cl_2$ ratio of 2.69 : 1, chlorosulfonylation is the main reaction and chlorination is a side reaction; with a decreasing ratio, the chlorosulfonylation rate drops and the chlorination rate rises; and at a sufficiently high $SO_2-Cl_2$ ratio the reaction goes to completion in 5 to 10 min; longer reaction times (greater radiation doses) result in sharply decreased radiation yield. At a ratio ≤1 : 1 both rates drop. A three-step reaction mechanism is postulated in which the addition of $SO_2$ to $CH_3$ side groups precedes $SO_2Cl$ group formation. Experiments with the use of $SO_2Cl_2$ in the gas mixture resulted only in chlorosulfonylation at a lower rate than with the $SO_2/Cl_2$ mixture. Gamma-radio-induced sulfoxidation with a mixture of $SO_2$ and $O_2$ is also reported. (OTS)

**28997** PHOTOCHEMICAL ANNEALING OF NEUTRON-IRRADIATED POTASSIUM SULFATE AND AMMONIUM SULFATE. Nikola Getoff (Österreichische Akademie der Wissenschaften, Vienna). Radiochim. Acta, 1: 49-51(Jan. 1963). (In German)

The photochemical annealing of neutron-irradiated potassium and ammonium sulfate was studied. It was found that by the action of ultraviolet light on potassium sulfate two kinds of fragments disappear simultaneously. The velocity constants of the two processes are: $k_A = 7.7 \times 10^{-6}$ and $k_B = 5.1 \times 10^{-5}$ $sec^{-1}$. On the other hand, neutron irradiated ammonium sulfate is obviously decomposed by reducing compounds or fragments when further irradiated by UV. (auth)

**28998** ON THE CHEMISTRY OF NUCLEAR PROCESSES. V. INVESTIGATIONS OF THE NEW MOLECULE FORMATION BY NEUTRON CAPTURE REACTIONS. F. Baumgaertner (Technische Hochschule, Munich) and U. Zahn. Radiochim. Acta, 1: 51-5(Jan. 1963). (In German)

In neutron irradiated $(C_6H_6)Cr(CO)_3$ the radioactive $Cr^{51}$ recoil atoms should be able to form, aside from the primary compound, both of the symmetric complexes, viz. $Cr^{51}(C_6H_6)_2$ and $Cr^{51}(CO)_6$. It was proved, however, that the formation of new molecules tends heavily towards $Cr^{51}(CO)_6$. The retentions were 10% for $C_6H_6Cr^{51}(CO)_3$, 13.5 % for $Cr^{51}(CO)_6$, and 0.24% for $Cr^{51}(C_6H_6)_2$. The formation of $C_6H_6Cr^{51}(CO)_3$ and $Cr^{51}(CO)_6$ could be increased to 12.5% and 16.5%, respectively, by annealing. An attempt was made to discuss these results on several conceptions. The most obvious explanation would be that the primary molecule is only partially destroyed, which, on the basis of the physical data known, should lead to a predominance of $Cr^{51}(CO)_3$ fragments. Thereby the favored formation of $Cr^{51}(CO)_6$ and new $C_6H_6Cr^{51}(CO)_3$ observed experimentally can be explained. (auth)

**28999** STUDY OF THE SZILARD-CHALMERS EFFECT ON Cu-PHTHALOCYANINE AND Na-PHTHALOCYANINE. M. Pertessis and R. Henry (Commissariat à l'Énergie Atomique, Saclay, France). Radiochim. Acta, 1: 58-62 (Jan. 1963). (In German)

The Szilard-Chalmers effect was studied on Na-phthalocyanine and on Cu-phthalocyanine preirradiated

with γ rays. With Na-phthalocyanine the yield of the Szilard-Chalmers reaction was investigated for different extraction methods, and the annealing by heat before and after the neutron irradiation. The annealing curves found showed an increase of yield, caused by molecule destruction. Cu-phthalocyanine was preirradiated with γ rays in air and in vacuo. This preirradiation gave different annealing effects for air and vacuum. After irradiation in air the retention curve rose rapidly up to a constant value, whereas in vacuo the retention rose linearly with the dose received. Annealing by preheating was studied, too. Retention increased with temperature and time of heating. The curve rose rapidly up to a constant value. The annealing by heat was investigated also on $K_2CrO_4$, but no increase of retention is found. (auth)

**29000** RADIATIVE THERMAL NEUTRON CAPTURE IN SOME PHOSPHORUS COMPOUNDS. R. F. C. Claridge and A. G. Maddock (University Chemical Lab., Cambridge, Eng.). Radiochim. Acta, 1: 80-3(Jan. 1963). (In English)

The radiophosphorus formed by the neutron irradiation of potassium or ammonium fluophosphates appears, after solution of the crystals in water, as $PF_6^-$, $PO_2F_2^-$, $PO_3F^{2-}$, $PO_4^{3-}$, $HOP_3^{2-}$, and $H_2PO_2^-$. The crystals show both thermal and radiation annealing, but are not sufficiently stable for detailed study of these effects. A very large difference was found between the behavior of single crystals and powdered material. A study of the retention of $P^{32}$ in phosphate as a function of composition of solid solutions of potassium dihydrogen phosphate in potassium dihydrogen arsenate gave a linear relation with phosphate content over a widerange of compositions, but a sharp change occurred near the pure phosphate composition. (auth)

**29001** THE ANNEALING OF RADIOLYTIC DAMAGE IN SOME NITRATES. A. G. Maddock and S. R. Mohanty (University Chemical Lab., Cambridge, Eng.). Radiochim. Acta, 1: 85-7(Jan. 1963). (In English)

The annealing of radiolytic damage in irradiated potassium and thallium nitrates is different from that of lead nitrate. In the case of potassium nitrate the transition introduces a more or less discontinuous recombination of fragments. In the thallium salt the low temperature annealing isotherm is not so very different from lead nitrate but a modest rise in temperature changes the characteristics of the process. Data are also given concerning the behavior on heating of irradiated barium nitrate, silver nitrate, and sodium nitrate. (auth)

**29002** QUANTITATIVE SEPARATION OF RUTHENIUM BY ION EXCHANGE AND SOLVENT PARTITION FROM FISSION PRODUCTS: RADIOCHEMICAL METHODS. A. Guillon, M. Colonomos, and R. Sauvagnac (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses, France). Radiochim. Acta, 1: 89-92(Jan. 1963). (In French)

The method proposed has the following advantages over distillation, precipitation, and solvent extraction: it is quantitative, fast, simply adaptable to distance work, and gives pure ruthenium. It is applied to fission products cooled longer than 50 days. The different ruthenium isotopes are separated, as anionic chlorocomplexes, from the other fission products adsorbed by a cationic resin; elution with 0.2N HCl gives back the anionic complexes. The formation of anionic ruthenium complexes does not contain any difficulties, if the irradiated fuel is dissolved in hydrochloric acid; in the case of nitric acid dissolution the transformation of the cationic nitric complexes into anionic chlorocomplexes is not instantaneous: the influence of $Cl^-/NO_3^-$ ratio and contact time between the nitric complexes and added chloride is shown. The only interference might come from hydrolysis of $Nb^{95}$ compounds; it is shown how to make this interference negligible. The radiochemical separation process is given in detail. The problem of counting $Ru^{103}$-$Rh^{103}$ and $Ru^{106}$-$Rh^{106}$ is mentioned. (auth)

**29003** STUDY OF THE SULFATE COMPLEXES OF NEPTUNIUM(IV). M. Cl. Musikas (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses, France). Radiochim. Acta, 1: 92-8(Jan. 1963). (In French)

The sulfate complexes of Np(IV) were studied polarographically. The half wave potential plotted against the concentration of bisulfate gave evidence of the existence of $NpSO_4^{2+}$ and $Np(SO_4)_2$. It was ascertained that Np(III) does not form stable sulfate complexes. The stability constant of $Np(SO_4)_2$ was found to be 4360. By potentiometric measurements (non zero current), the stability constants of $Np(SO_4)^{2+}$ and $Np(SO_4)_2$ were determined to be 312 and 3770. These values were calculated by the Leden method. (auth)

**29004** DISTRIBUTION OF $^{32}P$ BETWEEN THE PHOSPHORUS MODIFICATIONS AFTER NEUTRON-IRRADIATION OF WHITE PHOSPHORUS. J. Cífka (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Radiochim. Acta, 1: 125-8(June 1963). (In English)

White phosphorus was irradiated with neutrons and the distribution of radioactive phosphorus between the white and red allotropic modifications investigated. Approximately 66% of the activity was stabilized in the red modification of phosphorus. (auth)

**29005** STUDIES ON THE DIFFUSION OF $^{37}Ar$ AND THE THERMAL ANNEALING OF $^{51}Cr$ RECOIL IN NEUTRON IRRADIATED $CaCrO_4$-CRYSTALS. Nagao Ikeda (Universität, Cologne). Radiochim. Acta, 1: 129-36(June 1963). (In English)

The apparent similarity of the rare-gas diffusion and the recoil-annealing processes both resulting in "pseudo-plateaux" led to a study of these processes in $CaCrO_4$ crystals in order to find out a possible relationship. The material used was crystallized from solution, dried at room temperature (sample A) and at 200°C (sample B), an average grain size of 130 μ was selected and irradiated for 8 hours with pile neutrons in a flux of $4 \times 10^{12}$ n/cm$^2$ · sec. The diffusion of the homogenously distributed $Ar^{37}$, produced by the $Ca^{40}(n,\alpha)$ process was investigated in the temperature range from 100 to 800°C. The thermal annealing of $(n,\gamma)$ $Cr^{51}$ recoil fragments could be measured between 100 and 300°C. It was found that the percentage of released $Ar^{37}$ is much dependent on the thermal treatment of the $CaCrO_4$ crystals. For instance about 52% of the $Ar^{37}$ diffused in 3 hours at 300°C from sample (A), while from the tempered sample (B) only about 5% was lost. In both preparations the $Ar^{37}$ release reached 100% at about 800°C possibly favored by oxygen liberation. In the range of 300 ~ 700°C, linearity of log D with 1/T was observed. $Ar^{37}$ diffusion coefficients at 200°C were measured to be $6.0 \times 10^{-11}$ cm$^2$/sec for sample (A) and $7.7 \times 10^{-13}$ cm$^2$/sec for sample (B). At 300°C, $3.2 \times 10^{-10}$ for (A) and $1.1 \times 10^{-12}$ cm$^2$/sec for (B) were obtained. The initial retention of recoil $Cr^{51}$ was found to be 10% higher in sample B which can be explained by the fact that the instantaneous recombination reaction is hindered by adsorbed molecules and lattice imperfection. The thermal annealing at the earlier stage formally follows first order kinetics, the reaction rate constants are almost the same for both samples at a given temperature. In multistep annealing experiments $R_\infty$ reaches characteristic plateau-values which can be ob-

tained also by a single-step heating at the respective temperature. This is not the case in the multistep $Ar^{37}$ diffusion experiments which are found to be very sensitive to the "history" of the sample. The differences in the Ar diffusion and the $Cr^{52}$ annealing-multistep curves are explained by the pronounced physical and the more chemical nature of the processes involved. (auth)

**29006** HOT ATOM REACTIONS IN ORGANIC BROMIDES. J. H. Mallinson, G. E. Miller, and P. F. D. Shaw (Oxford Univ.). Radiochim. Acta, 1: 136-41(June 1963). (In English)

The yields of parent bromide from neutron irradiation of bromoethane, 1,1-dibromoethane, and 1,1,2,2-tetrabromoethane were measured as a function of either bromine or hydrogen bromide concentration. The results appear to be consistent with those predicted by the "billiard-ball" replacement mechanism. (auth)

**29007** RADIOCHEMICAL CHANGES IN POLYMERS. II. INFLUENCE OF OXYGEN DIFFUSION AND DEGREE OF POLYMERIZATION ON THE DESTRUCTION OF 1,4-DI-[5-PHENYL-OXAZOLYL-(2)]-BENZENE IN POLYSTYRENE. H. Heusinger and E. Weber (Technische Hochschule, Munich). Radiochim. Acta, 1: 141-6(June 1963). (In German)

Polystyrene films with 1,4-di-[5-phenyl-oxazolyl-(2)]-benzene (DPOO) as additive, irradiated in and without air. After the oxygen originally dissolved in the film was used up, the oxygen delivered by diffusion could only penetrate to a limited depth into the polymer, as an equilibrium occurred between oxygen supply by diffusion and oxygen consumption by reaction. This result followed from the destruction rate of DPOO and the change in polymerization degree of the polystyrene and was especially supported by investigations of the dependence on the film thickness. The high G-value of dissolved DPOO with respect to DPOO in substance must be attributed to an energy transfer from polystyrene to the additive. The influence of oxygen is shown by the fact that in the dose range investigated only with oxygen present does there occur destruction of DPOO in polystyrene. In addition, an influence of polymerization degree of the polystyrene on the destruction of the additive was discovered. It is therefore assumed, that the polymerization degree affects the number of radicals or excited states formed on the DPOO; it is shown that differences in the oxygen diffusion can explain this observation only in part. (auth)

**29008** CARRIER-FREE RaC BY ION EXCHANGE. Karl Gleu, Karl-Heinz Koenig, and Fritz Hoyer (Universität, Frankfurt am Main). Radiochim. Acta, 1: 164-6 (June 1963). (In German)

Carrier-free RaC ($Bi^{214}$) was isolated from radium solutions which were freed from all daughter products by anionic exchange with Nalcite WBR in 2N hydrochloric acid. About a month later the short-lived daughter products were formed again, while the final members, beginning with RaD, were not present yet. After the emanation was driven out, the RaC, present in those solutions free from RaD ($Pb^{210}$) and the isotopic RaE ($Bi^{210}$), was separated by cationic exchange with Nalcite HCR in 0.5N HCl. The radium was adsorbed quantitatively, while the RaC went through the column as anion. RaC prepared like that contains less than 1% RaB impurity and was completely free from radium. A following elution of the cation exchanger by 2N HCl gave the RaB. (auth)

**29009** THE RESOLUTION OF COMPLEX DECAY CURVES. K. E. Seyb (Johannes-Gutenberg-Universität, Mainz). Radiochim. Acta, 1: 167-70(June 1963). (In German)

After a simple mathematical treatment, the complex decay data of two genetic dependent or independent radioisotopes are plotted in a straight line. The method is used to determinate $Zr^{95}$ and $Nb^{95}$ in mixtures. (auth)

**29010** REACTIONS OF FISSION-RECOIL NUCLEI WITH METHANE AND BENZENE. Hans-Otto Denschlag, Norbert Henzel, and Guenter Herrman (Universität, Mainz). Radiochim. Acta, 1: 172-3(June 1963). (In German)

The reactions of fission-recoil iodine with methane and benzene were studied. A comparison of reaction yields with the primary fission yields is presented. (M.C.G.)

**29011** INVESTIGATIONS ON THE POSSIBILITIES OF ISOTOPIC EXCHANGES BETWEEN $C_3O_2$ AND CO LABELED WITH $^{14}C$, IN PRESENCE AND IN ABSENCE OF IONIZING RADIATIONS. Antonio Faucitano and Vera Maxia (Università, Pavia, Italy). Ric. Sci., Rend., (2) 3: 131-40(Mar. 1963). (In Italian)

The possibilities of isotopic exchanges in the system $C_3O_2-CO^{14}$ were studied in the presence and in the absence of $\gamma$ radiation and neutrons, in comparison with those occurring in the system $C_3O_2-C^{14}O_2$; the importance of water as promoter of exchanges in the system $C_3O_2-C^{14}O_2$ is shown. (auth)

**29012** EXPERIMENTAL METHODS FOR RADIATION-CHEMICAL INVESTIGATIONS ON A NUCLEAR REACTOR. B. S. Gudkov, B. G. Dzantiyev, V. N. Popov, and Yu. M. Rumyantsev. Tr. 2-go (Vtorogo) Vses. Soveshch. Radiats. Khim., Akad. Nauk SSSR, Otd. Khim. Nauk, Moscow, 1960, 733-7(1962).

Reactions between methane, ethylene, or acetylene and nitrogen and ammonia were studied in a 100 kv reactor under flow conditions. The exit gases were analyzed after being absorbed or frozen out. The change in product yield with dosage was studied by changing the gas velocity and with composition by changing the velocity of individual components, keeping the total constant. A model of a hot cell with direct input of reagents was also studied by depositing various quantities of uranyl nitrate or boron anhydride inside the chamber. Additional cleaning of the exit gases, to remove fission fragments, was required. In some experiments the dose and yield of product were found simultaneously, thermal-neutron flux being measured with a sodium indicator. For the system $C_2H_4 + NH_3$ the radiation chemical yield varied from 1 to 3 molecules of HCN per 100 ev. (TCO)

**29013** OPTICAL AND PHOTOELECTRIC PROPERTIES OF BARIUM AND STRONTIUM AZIDES. S. K. Deb (National Research Council, Ottawa). Trans. Faraday Soc., 59: 1423-8(June 1963).

Measurements were made of the ultra-violet absorption spectra and associated photo-electric properties of barium and strontium azides at 298 and 77°K in the wavelength range 1300-2500 Å. In barium azide the spectrum shows three well-defined absorption bands each having a multiple structure characteristic of the azide ion. A complex structure was observed in the fundamental absorption edge of strontium azide as well. The spectral distribution of photoconductivity and photoemission in barium azide and photoemission in strontium azide were measured. No definite conclusion could be reached about the structure observed in the optical absorption and the photocurrent spectra of the materials. (auth)

**29014** EPR SPECTRA OF CERTAIN γ-IRRADIATED AMINO ACIDS OVER A WIDE TEMPERATURE RANGE. S. Z. Shulga, A. I. Telyatnik, O. M. Taranukha, and E. P. Sidorik (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 8: 460-8 (1963). (In Ukrainian)

The EPR spectra of a great number of amino-acids irradiated by a cobalt γ-source were studied. An assumption is made as to the structure of free radicals arising in some of the investigated substances. The spectrum of irradiated DL-norleucine differs from that obtained by others, who used an X-ray tube for irradiation. The temperature dependence of the spectra was studied over a range from room temperature to that of liquid hydrogen. Expansion of the hyperfine structure component was observed, that is explained by freezing of the rotary motions of the radicals leading to averaging of the dipole-dipole interaction. In some cases a slight change was noted in the value of hyperfine splitting. Improvement of the symmetry of the hyperfine structure picture during cooling was noted in some specimens. An attempt is made to explain this phenomenon. A study was made of the change in EPR spectra due to recombination of free radicals, occurring as a result of heating the samples at 100°C. (auth)

**29015** STUDIES ON X-AGENT. XXVI. VARIOUS FACTORS WHICH AFFECT THE PRECIPITATION OF BISMUTH OXYCHLORIDE. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 14: 21-9(Feb. 1963). (In English)

The cloudiness of the solution produced by mixing bismuth chloride with water is markedly influenced by the manner in which the two components are mixed. However, striking dissimilarity in the cloudiness cannot be avoided even when every possible care is taken in the mixing manner. This is not attributable to any dissimilarity in temperature or in light or in the size of test tubes. It is believed that an unknown agent (X-agent), which has radiation properties, is responsible for the dissimilarity. (P.C.H.)

**29016** STUDIES ON X-AGENT. XXVII. EFFECT OF A SUBSTANCE ON THE PRECIPITATION OF BISMUTH OXYCHLORIDE WHICH IS FORMED IN A TEST TUBE PLACED NEAR THE SUBSTANCE. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 14: 31-42(Feb. 1963). (In English)

The colloidal precipitation of bismuth oxychloride, which is produced by the addition of water to bismuth chloride solution, was found to be affected by the rate at which the water is added to the solution. Precipitation is more marked by prompt addition than by slow addition. The difference in the precipitation between the two ways of addition of water is very variable with time and place when and where the precipitation is formed. The difference is also affected by a substance that is placed near the test tube in which the precipitation is formed. This can be accounted for by the involvement of the X-agent in the precipitation, since it has been repeatedly demonstrated that the X-agent is essential in its property of varying incessantly with time and space, and that when it comes across a substance, secondary or changed agent appears to be scattered around the substance. (P.C.H.)

**29017** STUDIES ON X-AGENT. XXIX. INTERFERENCE OF GAMMA-RAYS WITH THE ACTION OF X-AGENT ON THE PRECIPITATION OF BISMUTH OXYCHLORIDE. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 14: 89-99(Apr. 1963). (In English)

It was demonstrated that the gamma ray emitted from $I^{131}$ appears to be capable of interfering with the action of X-agent on the precipitation of bismuth oxychloride. (P.C.H.)

**29018** SCINTILLATION LIGHT YIELDS AND THEIR DIRECTION DEPENDENCE AS A FUNCTION OF TEMPERATURE FOR ANTHRACENE, TRANS-STILBENE, AND PARA-TERPHENYL CRYSTALS FROM BOMBARDMENT WITH α RADIATION. Herbert Hansen (Universitat, Gottingen, Ger.). Z. Physik, 173: 231-9(1963). (In German)

The scintillation light yield of thin trans-stilbene, para-terphenyl, and anthracene crystals and an organic plastic scintillator bombarded with α particles of ThB($Pb^{212}$) was measured as a function of temperature between t = 20°C and the melting point. The light yield of all the specimens investigated was found to be reduced with increasing temperature. In all cases at the melting point the light yield was zero. The scintillation anisotropy of the organic crystal scintillators also was investigated over the range of temperature mentioned above, and there it is independent of temperature and retains the value measured at room temperature. (auth)

**29019** RADIATION POLYMERIZATION OF VINYL ACETATE. Masakazu Matsumoto and Kiyokazu Imai (to Kurashiki Rayon Co., Ltd.). U. S. Patent 3,096,267. July 2, 1963. Priority date June 4, 1959, Japan.

Polymerization of vinyl acetate by placing the monomer in a solvent of water and a water-soluble solvent and subjecting the solution to high energy radiation gives a polyvinyl acetate that can be converted to polyvinyl alcohol with excellent crystalline properties. Numerous solvents and radiation sources can be used, the radiation intensity and time depending mainly on the desired polymerization. Ready control is also maintained over the polymerization process. (D.C.W.)

**29020** IRRADIATED, CROSS-LINKED POLYETHYLENE COPOLYMER. William C. Rainer, Edward M. Redding, Joseph J. Hitov, Arthur W. Sloan, and William D. Stewart (to W. R. Grace and Co.). U. S. Patent 3,097,150, July 9, 1963. Filed June 24, 1955.

Irradiation of polyethylene in the presence of other non-polar or slightly polar polymers or ethylenically unsaturated monomers produces cross-linked polymers with greater rigidity, strength and heat resistance. Polymers of isobutylene can be used with particular advantages. Radiation of at least 750 kev and at a dosage of at least $2 \times 10^6$ REP is used. (D.C.W.)

## Raw Materials and Feed Materials

**29021** A STUDY OF THE PREPARATION OF AMMONIUM URANIUM FLUORIDE BY ELECTROLYSIS WITH MERCURY CATHODE. M. L. Acena Barrenecha, T. Batuecas Rodiguez, F. de la Cruz Castillo, and R. Fernandez Cellini (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 59: 85-100(Feb. 1963). (In Spanish)

The possibility of industrially obtaining uranium ammonium fluoride by means of an electrolytic procedure using a mercury cathode and a rotating platinum anode was successfully demonstrated as applied to uranyl solutions containing added ammonium fluoride. Such solutions represented the eluates of alkaline uranium leach solutions previously fixed on anion exchange resin beds. The involved processes are: ore leaching by carbonate solutions, ion ex-

change concentration and purification of the resulting attack solutions, recycling of the partially exhausted feed solutions, electrical current yields, characteristics of the obtained solid products, etc. From its properties concerning chemical purity as well as active surface it could be stated that the uranium tetrafluoride resulting from the sublimation of the obtained double uranium ammonium fluoride satisfactorily conforms with the requirements established for its subsequent use to prepare uranium metal for nuclear uses. (auth)

**29022** IMPROVEMENTS IN OR RELATING TO THE RECOVERY OF URANIUM VALUES. John Child (to United Kingdom Atomic Energy Authority). British Patent 926,636. May 22, 1963. Filed Jan. 14, 1960.

A method of recovering U values from a fluoride slag of a reducing metal, such as Mg, is patented. The slag is treated with a mixed aqueous solution of either the nitrates or sulfates of Al and Na. This brings the slag into solution as sodium aluminum fluoride along with the metal and uranyl salts corresponding to the Al and Na salts used. Sodium aluminum fluoride is soluble in aqueous Al salt solutions. U can be recovered from the solution by solvent extraction or ion exchange. (M.P.G.)

**29023** PROCESS FOR THE LIXIVIATION OF URANIUM-BEARING ORES. Pierre Mouret, Paul Pottier, Jean Le Bris, and Alban Villa (to Commissariat à l'Énergie Atomique). British Patent 927,315. May 29, 1963. Priority date Nov. 5, 1958, France.

A patented process for leaching a U-bearing ore consists of allowing a dilute aqueous solution of an alkali-metal carbonate and/or bicarbonate to seep uniformly distributed through a mass of crushed ore, without free gravitational flow of solution between the particles of ore. The volume of solution passed through the mass of ore should be between 0.5 and 10 liters/$m^2$ of superficial surface of the mass of ore/hr. The solution can be recycled for further leaching. Rain water falling on the mass of ore is prevented from upsetting the leaching conditions by varying the concentration of solution according to the amount of rain water. (M.P.G.)

**29024** THORIUM RECOVERY FROM BARREN URANIUM LEACH LIQUORS. Richard A. Mock and William N. Vanderkooi (to Dow Chemical Co.). U. S. Patent 3,091,512. May 28, 1963. Filed Dec. 15, 1959.

A low-cost process is patented for recovery of Th from acidic barren leach liquor containing Th, ferric iron, and phosphate in aqueous solution. The leach liquor is brought into intimate contact with a bed of metallic Fe, substantially in the absence of air. The soluble phosphate is transformed into a thorium-phosphate-containing sludge, which is precipitated from the solution and may be recovered from the barren leach liquor. Details of the process and examples are given. (M.P.G.)

## Separation Processes

**29025** (AERE-R-4358) THE SEPARATION OF THE RARE EARTHS BY PARTITION CHROMATOGRAPHY WITH REVERSED PHASES. PART III. THE USE OF BATCH EXTRACTIONS TO OBTAIN DISTRIBUTION DATA. T. B. Pierce and R. S. Hobbs (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1963. 10p.

The distribution of the elements neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, and erbium between aqueous perchloric acid and a solid phase consisting of di(2-ethylhexyl) hydrogen phosphate retained on a poly (vinyl chloride/vinyl acetate) copolymer was investigated by a batch extraction technique. The dependency of distribution ratio on hydrogen ion concentration of the aqueous phase and total quantity of rare earth partitioning was determined and the apparent capacity of the solid phase found. Results are compared with figures obtained from elutions when the rare earths are eluted chromatographically from a column of the solid phase. (auth)

**29026** (HW-73288) $I^{131}$ SAMPLING SYSTEM EFFICIENCIES AT PUREX AND REDOX STACKS. J. D. McCormack (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 1, 1962. Contract AT(45-1)-1350. 11p.

The relative $I^{131}$ sampling efficiencies were measured for the sampling systems in the Redox and Purex stacks. At Redox the 20 ft system yields iodine concentrations 12% higher than the concentration simultaneously indicated by the 50 ft level system. The 50 ft system at Purex indicates $I^{131}$ concentrations 10% higher than those samples of stack gas obtained at the 196 ft level. In view of the small differences in the iodine concentrations in the gas samples for the rather different pairs of sampling systems, it was concluded that retention of gaseous $I^{131}$ in the sample piping was of minor importance. Activated charcoal cartridges were used to collect the iodine. The precision of this method was adequate for field use. The lower than expected retention of iodine on the charcoal indicated that a small fraction of the $I^{131}$ might have been present in a form other than elemental iodine, or that some constituent of the stack gas reduced the absorption of iodine onto the activated carbon. (auth)

**29027** (LAMS-2884) PROCESSING OF UC–PuC WITH TRIBUTYL PHOSPHATE. D. F. Bowersox (Los Alamos Scientific Lab., N. Mex.). Feb. 4, 1963. Contract W-7405-eng-36. 15p.

Uranium carbide–plutonium carbide buttons, $U_{0.8}Pu_{0.2}C_{0.95}$ by weight, dissolved in hot 13M $HNO_3$–0.05M HF solution. The rate of surface dissolution at 100°C was 150 mg $cm^{-2}$ $min^{-1}$. Dissolution solutions were subsequently adjusted to 1.5 to 4M in $HNO_3$, 0.1M in $Al(NO_3)$, 1.6 g U/l, and 0.4 g Pu/l, and the distribution coefficients between these feed solutions and 30 v/o TBP were measured. Both Pu(IV) and U(VI) distribution coefficients indicated that quantitative extraction into TBP was feasible. Both elements were stripped from the organic phase by 0.01M $HNO_3$ solution. A 0.03M $Fe(NH_2SO_3)_2$ in 0.5M $HNO_3$ solution removed Pu preferentially from TBP. In three cycles the U in this Pu-rich strip was reduced to 500 ppm. U(VI) was then stripped from the TBP with 0.01M $HNO_3$. This U-rich strip contained less than 50 ppm Pu. (auth)

**29028** (NAA-SR-Memo-8465) REMOVAL OF FISSION PRODUCT ELEMENTS BY GASEOUS CHLORIDE TREATMENT. I. J. Groce (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 13, 1963. Contract AT-11-1-GEN-8. 12p.

In the low decontamination reprocessing of refractory fuels, powdered $UO_2$ is formed as an intermediate. The $UO_2$ powder may then be treated at elevated temperatures with a mixture of hydrogen and hydrogen chloride gases to remove some of the fission product elements as the chlorides. Several of the fission product elements were studied from the standpoint of neutron capture. The relative importance of removal after a theoretical burnup cycle of 15,000 Mwd/MTU was calculated to be: Nd, Rh, Sm, Tc, Pm, Eu, Mo, Pr, and La. If $Sm^{149}$, Cs, and the inert gases are

omitted, these elements contribute approximately 95% of the total neutron capture due to fission product elements. The rare earths account for about 64% of the neutron capture and Nd and Sm account for about 40%. From a thermodynamic consideration, the formation of the chlorides appeared to be more favorable at temperatures below 1000°K. In practice, however, when trace-irradiated $UO_2$ was treated at 925°K with a mixture of $H_2$ + HCl for 3 hours followed by 3 hours in vacuum at 1425°K, very little decontamination was noted. On the other hand when trace-irradiated $UO_2$ was heated to 1650°K for 5 hours in flowing $H_2$ + HCl, 70 to 80% of the rare earth elements were removed. By treating $UO_2$ powders with chlorine for 3 hours at 720°K prior to the high-temperature $H_2$ + HCl treatment, over 90% of the ruthenium and molybdenum was removed. None of the rhodium, which accounts for 16% of the neutron capture, could be removed by either of these treatments. When coprecipitated blends of $UO_2$–2% $Nd_2O_3$ and $UO_2$–2% $Sm_2O_3$ were heated to 1650°K for 5 hours in flowing $H_2$ + HCl, 50 to 70% of the $Nd_2O_3$ and 40 to 50% of the $Sm_2O_3$ were removed. (auth)

**29029** DISMANTLING OF THE FONTENAY-AUX-ROSES PLUTONIUM EXTRACTION PILOT PLANT. P. Cerré. Bull. Inform. Sci. Tech. (Paris), No. 70, 55-74 (Mar. 1963). (In French)

The building plans and noteworthy uses of the plant are outlined. The removal of wastes and other special materials is described. The disassembly and removal of process machinery is summarized. Decontamination aspects are considered. Personnel protection by means of clothing, masks, ventilation, personnel and material rotation, etc., is discussed. (T.F.H.)

**29030** PARTITION OF TETRAVALENT AND PENTAVALENT PROTACTINIUM BETWEEN VARIOUS AQUEOUS SOLUTIONS AND TRI-N-OCTYLAMINE. Roland Muxart and Hélène Arapaki-Strapélias (Institut du Radium, Arcueil, France). Bull. Soc. Chim. France, No. 4, 888-91(Apr. 1963). (In French)

The partition of penta- and tetravalent Pa between sulfuric and hydrochloric aqueous solution and a solution of tri-n-octylamine in xylene was studied. $Pa^{4+}$, just as $Th^{4+}$, is not extracted from hydrochloric acid solutions at concentrations less than 6M by a 5% solution of tri-n-octylamine. $Pa^{5+}$, on the contrary, is extracted almost quantitatively. In sulfuric acid solution $Pa^{4+}$ and $Pa^{5+}$ are more than 95% extracted at 0.12 and 0.25M $H_2SO_4$ respectively. The variation of the distribution coefficient with the concentration of tri-n-octylamine, at constant acidities, allows some hypotheses on the nature of the Pa complexes in these media to be formulated. (tr-auth)

**29031** RARE EARTH CHROMATOGRAPHY USING BIS-(2-ETHYLHEXYL) ORTHOPHOSPHORIC ACID. John W. Winchester (Massachusetts Inst. of Tech., Cambridge). J. Chromatog., 10: 502-6(Apr. 1963).

Sharp separations of microgram amounts of the lanthanide elements as trivalent ions in aqueous hydrochloric acid solution are made chromatographically using a column of diatomaceous silica made hydrophobic with dichlorodimethylsilane vapors and coated with high purity bis-(2-ethylhexyl) orthophosphoric acid (DEP). Separation factors averaging 2.5 for adjacent rare earths are observed, as in solvent extraction using DEP, such that the higher atomic number elements are more tightly held by the column. The kinetics of the sorption–desorption process appear to be very fast, but elutions at 70° appear to be somewhat sharper than at 25°, especially at high flow rates and high loading. A heated column 5 cm long and 2 $cm^3$ total volume (70% void space) has been used to separate 15 micrograms of mixed lanthanides from each other in 3 hr using a stepwise gradient from 0.14 to 3.8N HCl. La is eluted first, and Y is eluted together with Er. (auth)

**29032** COMPUTER CALCULATION OF FLOWSHEETS FOR REPROCESSING NUCLEAR FUELS. W. R. Burton (United Kingdom Atomic Energy Authority, Risley, Eng.) and A. L. Mills. Nucl. Eng., 8: 248-52(July 1963).

A description is given of the work carried out on the evaluation of flowsheets for the countercurrent extraction of U-Pu fuels in aqueous $HNO_3$ solutions with a solution of tributyl phosphate in odorless kerosene. The treatment of the fuels and the correlation of the data are described. A nomogram is given for estimating the distribution of Pu and U between water and the organic phase. A computer program, Simtex, was developed to carry out calculations for establishing optimum flowsheets. The properties and uses of the program are described. (D.L.C.)

**29033** RECOVERY AND PURIFICATION TESTING OF CARRIER-FREE $Y^{90}$. E. Niemann and K. Fruehauf (Farbwerke Hoechst AG, Frankfurt am Main). Radiochim. Acta, 1: 55-8(Jan. 1963). (In German)

$Y^{90}$ of high radiochemical purity was obtained by elution with a pyridine citrate buffer (pH 4.0) of a cation exchanger charged with $Sr^{90}$. The decontamination factor exceeded $10^7$, if the eluate was purified via a second ion exchange column. A column charged with 50 mc $Sr^{90}$ yielded an eluate with ~9 mc $Y^{90}$/ml. To assess the purity of the $Y^{90}$ solution, a rapid electrophoretic method was developed, requiring 1% of the total activity. Thus, decontamination factors up to $2.10^7$ can be determined, corresponding to 2 nc $Sr^{90}$ in 40 mc $Y^{90}$. After the decay of the $Y^{90}$ activity obtained, the $Sr^{90}$ impurity is counted in equilibrium with its daughter. The decontamination factors so determined are compared with those found by the rapid procedure. By studying yield and purity of the $Y^{90}$ product it was shown that columns containing 20 to 50 mc $Sr^{90}$ are suited for routine production of high purity $Y^{90}$. (auth)

**29034** THE EXTRACTION OF URANIUM AND PLUTONIUM FROM NITRIC ACID SOLUTIONS BY TERTIARY AMINES. F. Baroncelli, G. Scibona, and M. Zifferero (Comitato Nazionale per l'Energia Nucleare, Rome). Radiochim. Acta, 1: 75-9(Jan. 1963). (In English)

In the extraction of Pu(IV) nitrate from uranium containing aqueous solutions by means of long chain tertiary amines, the partition coefficient of Pu(IV) is influenced by the concentration of nitric acid, uranyl nitrate, and by the concentration of the amine in the diluent. At high uranium concentration extraction of Pu(IV) ceases to be dependent upon the nitric acid molarity. The existence of a competitive effect between U and Pu is shown. The effect of the chemical composition of the amine-diluent system on the uranium-plutonium separation factor is briefly discussed. (auth)

**29035** $^{234}Pa$ PRECIPITATION WITH BENZOYL-PHENYL-HYDROXYLAMINE. O. Cristallini and J. Flegenheimer, (Comisión Nacional de Energía Atómica, Buenos Aires). Radiochim. Acta, 1: 157-61(Jan. 1963). (In English)

The coprecipitation of $Pa^{234}(UX_2)$ with benzoyl-phenyl-hydroxylamine from acid solutions of uranium was studied. The Pa/Th separation factor with this method was very high and was compared with that of the phosphate method. The clean disintegration curve which can be obtained and the simplicity of the method recommend it for teaching experiments in radiochemistry showing the technique of working with short-lived isotopes, analysis of data from

a rapidly decaying source, and the determination of the resolving time of the counting system. (auth)

**29036** ON THE FAST CHEMICAL SEPARATION OF CARRIER-FREE SAMPLES FROM MACRO-AMOUNTS OF PROTON-IRRADIATED RARE-EARTH TARGETS. G. K. Oelsner-Ryde (Nobel Inst. of Physics, Stockholm). Radiochim. Acta, 1: 170-2(June 1963). (In English)

The formation of precipitates, which appeared in the body of the cation-exchange resin beds during the chemical separation of carrier-free samples from proton-irradiated cyclotron targets of more than 50 mg of rare-earth oxides, was investigated. The properties and character of this insoluble salt are discussed. A method for such a separation, which avoids the disturbing influence of a precipitate, is given. The sample produced is suitable for beta spectroscopy. The method described is applicable to fairly short-lived rare-earth isotopes, as the procedure can be carried out within 8 hours. (auth)

# ENGINEERING AND EQUIPMENT

## General and Miscellaneous

**29037** (CEA-2240) CONTRIBUTION EXPÉRIMENTALE A L'ÉTUDE DES PALIERS A GAZ. (Experimental Contribution to the Study of Gas Bearings). Gérald Gobert (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1962. 95p.

Thesis submitted to Paris Université.

Developments for gas-lubricated bearings are discussed. The study of how the fluid film behaves compared to what one can expect is discussed. Various devices are described which have allowed us to go up to peripheral velocity greater than 400 m/s, leading to rotational speed of several thousand revolutions per second. This is obtained by using an automatic setting for the distance between fixed and rotating walls. (auth)

**29038** (DEG-Report-201) DUAL PRESSURE STEAM CYCLE ANALYSIS. F. Kay (United Kingdom Atomic Energy Authority. Development and Engineering Group, Risley, Lancs, England). Mar. 23, 1961. 33p.

Calculation of the efficiency of a dual pressure steam cycle, which is programed on the Mercury and IBM 704 computers at Risley, is described. Results show the variation of cycle efficiency with reactor coolant temperatures and indicate that limits of application exist beyond which the use of a dual pressure cycle in conjunction with a reactor system is not feasible. (auth)

**29039** (HW-73404) PARTICLE DEPOSITION IN A ONE-HALF INCH CONDUIT. V. F. FitzPatrick, S. M. Nielson, and L. C. Schwendiman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 8, 1962. Contract AT(45-1)-1350. 16p.

Experiments were performed to study turbulent deposition of ZnS particles in a vertical aluminum tube. Brownian motion, thermal gradients, and gravity effects were negligible. Electrostatic forces were not separately evaluated and may have influenced the observations. The results, which are shown graphically, confirmed that the deposition constant is approximately proportional to the 5th power of the velocity. The data support the general form of a semi-empirical equation that expresses the correlation between the deposition constant and the parameters controlling particle deposition. Particles of mass median diameter of 4.2 $\mu$ deposited in the 60-ft tube to the extent of about 60% at a flow of 580 cm/sec, and about 90% at a flow of 1480 cm/sec. (auth)

**29040** (IS-562) DESIGN, CONSTRUCTION, AND PERFORMANCE OF TWO COMPACT AIR COOLED SODIUM HEAT EXCHANGERS. William F. Brown, Ray W. Fisher, and Henry M. Black (Ames Lab., Ames, Iowa). May 1963. Contract W-7405-eng-82. 59p.

A bare-tube crossflow heat exchanger and a finned-tube crossflow heat exchanger were designed, constructed, and tested. The exchangers have sodium as a tube side fluid and air as a shell side fluid and are constructed of Inconel. The bare-tube heat exchanger has three unmixed passes on the sodium side and one mixed pass on the air side. The finned-tube heat exchanger has one unmixed pass on the sodium side and one mixed pass on the air side. Both exchangers were designed to have a 10-kw heat exchanger rate at 1500°F, 600 lb/h on the sodium side and at 80°F inlet temperature, 200 lb/h on the air side. The tests were run from 1 to 4 kw at sodium temperatures up to 830°F and sodium flow rates up to 2500 lb/hr. The inlet air temperatures were about 80°F. The maximum air flow was 220 lb/hr. The maximum pressure drop on the air side of the bare-tube heat exchanger was found to be 0.15 in. of water. The pressure drop on the air side of the finned tube heat exchanger was negligible. The sodium side was tested for pressure drop with water, and principles of dimensional similitude were applied to the test procedure to predict pressure drop in the sodium system. The maximum predicted pressure drop in the sodium system was 10 psi in the bare-tube heat exchanger and 1 psi in the finned-tube heat exchanger. The heat transfer coefficients for the air side are presented in the form of a Stanton number. (auth)

**29041** (TID-18970) QUALITY CONTROL OF CIRCULATING OIL SYSTEMS BASED ON INTERFACIAL TENSION AND OXIDATION STABILITY. Frederick William Taylor (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1963]. Contract W-7405-eng-26. 16p.

The maintenance of lubricating oils in circulating systems which ordinarily lubricate the bearings and gears of machines or motors as well as hydraulic systems in industry is discussed. Interfacial tension values can be useful in determining when to purify oil in order to prevent sludging of systems, and information as to the remaining service life or degree of inhibitor exhaustion may be swiftly obtained by rotary bomb oxidation testing. Oil decomposition products usually may be effectively removed by fuller's earth adsorptive filtration without reducing stability. (auth)

**29042** (UCRL-9658) AN IMPROVED SOCKING TECHNIQUE FOR MASTER SLAVES. T. C. Parsons, L. E. Deckard, and P. W. Howe (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 29, 1962. Contract W-7405-eng-48. 5p.

A technique for socking a pair of standard Model 8 master-slave manipulators is described. The technique is primarily concerned with the fabrication of the bellows section, which provides for Z motion as well as wrist movement and rotation. (N.W.R.)

**29043** (TRG-Inf-Ser-288) THE INFLUENCE OF HYDRODYNAMIC LUBRICATION ON THE DEVELOPMENT OF SLEEVE BEARINGS. W. Froessel. Translated by H. W. Curtis (U.K.A.E.A. Reactor Group, Risley, Lancs, Eng.) from Maschinenmarkt, 61: No. 40, (May 18, 1956). 12p.

General sleeve bearing design has already reached a position, by remarkable material and lubricant development, which allows normal sleeve bearing questions to be satisfactorily solved. Bearing demands of technology, especially with respect to high rpm, quiet, damped running, freedom from wear and noise, and small bearing clearances, have increased considerably. These high demands can be mastered with hydrodynamic lubrication. The conclusions resulting from this for sleeve bearing design are given. (auth)

**29044** UNIVERSAL MANIPULATOR. L. A. J. Gardiner (W.D.M. Ltd., Bristol, Eng.). Nucl. Energy, 191-5(July 1963).

An account is given of the design, construction, and development of a prototype manipulator for use in lead-shielded cells. The manipulator has an elbow joint located

inside the cell which allows the clamping jaws to be rotated and positioned where required. A load of 2 lb can be manipulated in any position at a distance of 48 in. from the cell face, and the maximum operating torque is 7 lb-in. (auth)

**29045** LOOKING INTO GLOVE BOXES. Nucl. Eng., 8: 234-6(July 1963).

A review is presented of glove boxes and their design, use, and manufacture. The design philosophy is discussed, and the Harwell standard boxes are described. (D.L.C.)

**29046** THE WINDSCALE CAVES. Nucl. Eng., 8: 242-4(July 1963).

The planning of the construction of the Windscale caves is described. Design details of the caves are given. The operation and status of the caves are described. (D.L.C.)

**29047** HOT CELLS. WORLD SURVEY. PART I. [A CHART]. Nucl. Eng., 8: 245-7(July 1963).

A chart is presented of the principal details of some of the world's hot cells in operation and under construction. The quantities tabulated include purpose, size, shielding, windows, viewing systems, manipulator equipment, and status. (D.L.C.)

**29048** A NEW LOCALIZATION APPARATUS FOR GAMMATRON 2. Ernst Kahr (Landeskrankenhauses, Graz). Strahlentherapie, 121: 69-74(May 1963). (In German)

A new adjusting device equipped with an image amplifier for the Gammatron 2 is reported. The device was set up for the first time in a hospital and has been in routine use for about one year. (auth)

**29049** WATER PURIFICATION SYSTEM. (Engineering Materials). (Westinghouse Electric Corp., Bettis Atomic Power Lab., Pittsburgh). 12 units. (CAPE-635).

A water purification system used with the Shippingport Pressurized Water Reactor is described. Flow diagrams, schematics, control and wiring diagrams, drawings of preheaters and heaters, and drawings of a 160 gph degasser and degasser column are included. (F.E.S.)

**29050** IN-PILE LOOP CORROSION EXAMINATION FACILITY. (Engineering Materials). (Oak Ridge National Lab., Tenn.). 9 units. (CAPE-987).

The facility is located in the High Level Radiochemical Laboratory. The area is divided into the receiving, machining, and weighing stations. The machining and weighing stations have a pool 3 ft 8 in. deep. The receiving station is 3 ft 8 in. × 3 ft 2 in. The machining station is 9 ft 2 in. × 6 ft 6 in. × 9 ft 3 in. long. Besides ports it has two ZnBr windows 2 ft 1 in. × 2 ft 4 in. × 3 ft wide. The weighing section is 3 ft 8 in. × 3 ft 2 in. × 5 ft 4 in. high. In this section are 2 lead glass windows 1 ft × 10.5 in. × 4 in. thick. A 5.5-in. thick cast lead door is used for servicing. Each side of the double door is 4 ft 10.375 in. × 1 ft 7.25 in. thick. (F.E.S.)

**29051** IMPROVEMENTS IN OR RELATING TO HANDLING APPARATUS. John Shaw Hollings and Ernest Raymond Unitt (to Rolls-Royce Ltd.). British Patent 923,442. Apr. 10, 1963. Filed Feb. 27, 1959.

An apparatus, which can move remotely an object from a storage chamber to a separate container, is patented. The apparatus consists of a handling device that is moved along a straight path by a pair of chains and a drive mechanism for driving the chains at the same or different speeds. When the chains are driven at the same speed, the handling device moves rectilinearly, and when the chains are driven at different speeds, movable parts on the handling device are actuated to engage or disengage an article. The chains are designed so that each chain opposes bending of the other chain. Details of the design are described and illustrated. (M.P.G.)

**29052** IMPROVEMENTS RELATING TO ULTRACENTRIFUGES. (to Ceskoslovenska Akademie ved). British Patent 924,723. May 1, 1963. Priority date Mar. 12, 1959, Czechoslovakia.

The design of an ultracentrifuge, in which the rotor is magnetically suspended and magnetically set in rotation, is patented. The rotor is of ferromagnetic material with minimum residual magnetism. It is not mounted in any bearings, but is carried by the magnetic field of a solenoid. The lower part of the rotor descends into a vessel of damping liquid in which there is a hollow cylinder for horizontal stabilization and damping of the rotor. The hollow cylinder is made of ferromagnetic material and is freely mounted on thin wires in the same magnetic field as the rotor. The design also includes an illuminating device in the axis below the rotor and a pick-up picture tube of a television set in the axis of the ultracentrifuge above the cell. (M.P.G.)

**29053** IMPROVED GREASES. Arthur Leslie Morris and Mervyn Reginald White (to Esso Research and Engineering Co.). British Patent 924,820. May 1, 1963. Filed Apr. 11, 1960.

Greases having enhanced thermal, mechanical, and radiation stability for lubricating moving parts associated with nuclear reactors are patented. The grease consists of a base oil thickened to a grease consistency with a bentonite-amine complex and containing a dispersion of carbon black. The amount of the bentonite-amine complex should be from 10 to 20% by weight of the total composition, and the ratio of carbon black to bentonite-amine complex should be from 1:1 to 1:20. The grease is prepared by stirring the bentonite-amine complex with the base oil at a temperature from 210 to 250°F, then adding the carbon black, cooling the mixture, and milling it to the required grease consistency. (M.P.G.)

**29054** IMPROVEMENTS IN HEAT RECOVERY INSTALLATIONS. Jean Frederic Tillequin (to Babcock and Wilcox, Ltd.). British Patent 925,159. May 1, 1963. Priority date July 28, 1960, France.

The design of an installation for the recovery of heat from a pressurized fluid is patented. The installation consists of a number of heat-exchange units, each of which has a vertically elongated pressure vessel or tower to be traversed by the fluid. The pressure towers are arranged in a circle, around an upright axis, and the heating fluid flows through them in parallel. Thermal expansion or contraction causes the towers to move away from or toward the axis, and the suspension of the towers is designed to permit such movements. Details and variations in the design are described. (M.P.G.)

**29055** IMPROVEMENTS IN OR RELATING TO REMOTE HANDLING TONGS. John Grant (to United Kingdom Atomic Energy Authority). British Patent 925,596. May 8, 1963. Filed June 23, 1960.

The design of remote-handling tongs to engage the end of a rod-like article is patented. The tong consists of a pivoted hand grip, a rod connected to and axially movable by the hand grip, a hollow shaft, a sleeve attached to the operative end of the shaft, a sliding member within the sleeve, and 2 bell crank levers pivoted on the sliding member. A first axial movement of the rod causes the levers to engage the end of a rod-like article. Further axial movement of the rod retracts the sliding member into the sleeve until a shoulder on the article abuts the end of the sleeve. This

holds the rod-like article, such as a radiation source tube, rigid and in axial alignment with the tong handle. (M.P.G.)

**29056** REMOTE MANIPULATING ARRANGEMENT AND DEVICE. (to Commissariat a l'Energie Atomique). British Patent 925,788. May 8, 1963. Priority date Aug. 19, 1960, France.

A remote manipulating arrangement, which enables several active cells to be served by a limited number of manipulators, is patented. The installation could consist of a single manipulator, but two manipulators, one for light work and one for heavy work, are preferred. The cells are aligned, and each has a door opening on to a common corridor. A manipulator is supported by a transfer turret, which is moved along the corridor and into the cells by a gantry on guideways. The gantry, turret, and manipulator are driven by electric motors via flexible cables, which extend from a point in the corridor to the gantry and from the gantry to the manipulator. (M.P.G.)

**29057** IMPROVEMENTS IN OR RELATING TO AIRTIGHT DISMOUNTABLE ENCLOSURES. Paul Cogez and Jacques Humbert (to Commissariat à l'Energie Atomique). British Patent 926,226. May 15, 1963. Priority date Dec. 10, 1959.

The design of an airtight enclosure for the manipulation of radioactive products or for permitting work to be done in vacuum or controlled atmospheres is patented. The enclosure is dismountable and is built up of a plurality of rectangular frames, which can be closed to form panels. The edges of the frames can be joined to ensure airtight assembly of two adjacent frames, either in the same plane or at right angles. Special sealing strips and clamping devices are included in the design. The enclosure has the advantages of flexibility in volume, small bulk for storage in the dismantled state, and ease of cleaning and decontamination. (M.P.G.)

**29058** IMPROVEMENTS IN OR RELATING TO ENDOSCOPIC TELESCOPES. (to Commissariat à l'Énergie Atomique). British Patent 926,779. May 22, 1963. Priority date Apr. 1, 1960, France.

An endoscopic telescope for observing the inside of an enclosure, such as a hot cell, through a wall of considerable thickness is patented. The telescope consists of an objective and an eyepiece with aligned optical axes and one or more optical transmission systems between the eyepiece and the objective. Each transmission system is composed of two transmission members, each of which consists of two identical convex lenses and a cylindrical block of light-transmitting material between the lenses. The length of the block is equal to the product of the focal length of one of the lenses and the refractive index of the block. The lenses may be cemented to the cylindrical block. If the telescope is used for observing the interior of hot cells, the cylindrical blocks must be made from a material such as lead glass, which absorbs harmful radiations. (M.P.G.)

**29059** SELF-PROPELLED SUPPORTING CARRIAGE. (to Commissariat à l'Énergie Atomique). French Patent 1,211,626. Mar. 17, 1960. Filed Aug. 30, 1958.

A supporting carriage is adapted to roll alternately on circular rails, e.g., disposed around a nuclear reactor and on radial rails disposed perpendicularly to the circular ones. The carriage comprises at least two convergent axles for rolling on the circular rails and at least two parallel axles for rolling on the radial rails. At least one of each of the two groups of axles is a driving axle, while at least the axles of one group are mounted on jacks adapted to raise or to lower them with respect to the axles of the other group. Means are provided for detecting rails perpendicular to the rails on which the carriage is rolling at a given moment and for stopping the carriage in a position where the wheels of the axles at this moment are inactive and in alignment with the detected rails. (NPO)

**29060** DUCT SUPPORT. (to General Electric Co., Ltd.). French Patent 1,277,491. Oct. 23, 1961. Priority date Jan. 7, 1960, Great Britain.

In an installation having ducts through which a hot fluid circulates, it is necessary to compensate for the thermal expansion of these ducts. Generally the ducts are subdivided into a series of rigid parts mutually coupled by bellows. In order to avoid dangerous bending moments at the places where the ducts are welded to a vessel, e.g. the pressure vessel of a nuclear reactor, these parts are suspended by lever systems so that the weight of the part in question acts on the corresponding lever system in such a manner that there are created two reaction forces. The first force is constant and forms a direct reaction to the weight, while the second one is variable and acts against the reaction forces of the deformed bellows. (NPO)

**29061** DEVICE FOR HOISTING AND WINDING UP OF CABLES ESPECIALLY SERVING AS ELECTRIC CONDUCTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,284,097. Jan. 2, 1962. Priority date Jan. 15, 1960, Great Britain.

A T.V. camera adapted to be lowered into a channel of a nuclear reactor is suspended by means of a flexible pipe which supplies cooling fluid and encloses electrical conductors for the operation of the camera. Two drums are mounted on a common axis. The pipe is connected at a fixed point of the first drum to a fluid supply. The electrical conductors pass from the first to the second drum which they leave tangentially and via an apparatus to take up the slack, pass to a fixed point. This apparatus consists of two sets of pulleys, one of them being fixed, the other one being movably mounted on a lever. (NPO)

**29062** REMOTE-CONTROLLED MANIPULATING APPARATUS. Guy Cherel and Henri Forey (to Commissariat a l'Energie Atomique). U. S. Patent 3,090,509. May 21, 1963. Filed Jan. 14, 1960.

A remote-controlled apparatus for manipulating radioactive materials in sealed chambers is patented. All of the control units outside the chamber are mounted in a box, which is movable on the roof of the sealed chamber. All of the operating units within the chamber are mounted in a movable box on the inside surface of the roof and are capable of following all of the movements of the external box. Connections between the control and operating units are effected by means of two rotary magnets, one on each side of the roof of the chamber. Therefore, no openings in the walls of the sealed chambers are required. Transmission of commands from the operator to the controlling external box is effected through electric cables, and movement of the external box is effected by means of electric motors. Details of the apparatus are described and illustrated. (M.P.G.)

**29063** ARRESTING DEVICES FOR FALLING BODIES. Graham Eades Lindsay and Sidney John Joslin (to United Kingdom Atomic Energy Authority). U. S. Patent 3,096,268. July 2, 1963. Priority date June 14, 1956, Great Britain.

A spring on which the body (control rod, etc.) to be arrested is supported by shear pins within a housing absorbs the initial shock as the housing falls against the face of the control rod hole. If the limit of the shear pins is exceeded,

the control falls free, and an impact pin on its bottom strikes an impact base. Cutting edges on the top of the pin slice a steel liner in which the pin is inserted, thereby absorbing the remainder of the body's energy. (D.C.W.)

**29064** ACCELERATING STRUCTURE FOR A CHARGED PARTICLE ACCELERATING SYSTEM. Haywood Shelton and John M. Sellen, Jr. (to Thompson Ramo Wooldridge Inc.). U. S. Patent 3,096,456. July 2, 1963. Filed Oct. 12, 1960.

An accelerating electrode system for ionic propulsion systems consists of ribbons of a material (copper, for instance) whose disintegration under ion bombardment would not impair the operation of the W emitter. A system for detecting sputtering would actuate a motor arrangement that would move fresh ribbon into place as electrode erosion from ion bombardment occurred. The ribbons would be heated to eliminate adsorbed cesium, thereby preventing electron emission from the electrodes. Improved ion optics would also be used to control accelerating electrode sputtering. (D.C.W.)

**29065** LIQUID-LIQUID CONTACTING APPARATUS. Leonard Lowes and Maurice Charles Tanner (United Kingdom Atomic Energy Authority). U. S. Patent 3,097,071. July 9, 1963. Priority date Jan. 10, 1957, Great Britain.

A design for an in-line mixer-settler arrangement of simplified construction requiring no external pipework connecting between mixers and settlers is described. The conveyance of liquids in the apparatus is achieved by providing ports through interconnecting walls in the structure. (P.C.H.)

**29066** ACTUATOR FOR ELECTRICALLY OPERABLE DEVICE. James Herbert Bloor and Frederick George Chandler (to United Kingdom Atomic Energy Authority). U. S. Patent 3,097,327. July 9, 1963. Priority date Feb. 8, 1958, Great Britain.

The actuator consists of two electrical circuits, one of which includes in series a relay connected to a switching device with an operation-extender (capacitor) connected across the relay. The second circuit consists of a contact connected to a second switching device. Operation of the relay moves the contact from a first to a second position to allow current to pass through the electrically operable device. The device is actuated only when the right sequence of switching operations is used within the allotted time. (D.C.W.)

## Heat Transfer and Fluid Flow

**29067** (AEEW-R-258) TWO MODELS FOR THE DYNAMICS OF A CROSS FLOW HEAT EXCHANGER. A. Hopkinson (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Dec. 1962. 22p.

Two models of a cross-flow heat exchanger, a concentric tube counter flow model and a cross-flow model, are studied theoretically. Differential equations describing the behavior of the models are derived, and from them equations for the steady-state temperatures and the temperature transfer functions are obtained. (auth)

**29068** (BM-RI-6255) EXPERIMENTS WITH SOLID-IN-GAS SUSPENSIONS AS HEAT TRANSPORT MEDIUMS. W. T. Abel, J. P. O'Leary, D. E. Bluman, and J. P. McGee (Bureau of Mines. Morgantown Coal Research Center, W. Va.). Dec. 1962. 21p.

Laboratory tests were conducted with a closed, recycling system to evaluate the effectiveness of solid-in-gas suspensions as heat transport media. Micronized graphite in helium or nitrogen was circulated by a centrifugal compressor to determine the feasibility of the method and heat transfer capabilities of the mediums. Suspensions were circulated without plugging or eroding the compressor or piping. At low flowrates and light (0.1 to 0.2 vol %) graphite loadings, slightly less power was required to transport a given amount of heat with suspensions than with helium alone. Graphite deposition on the heat exchange surfaces of the cooler decreased the heat transfer effectiveness at higher solids concentration. Efforts to eliminate deposition are described. (auth)

**29069** (GEAP-4202) TWO-PHASE PRESSURE LOSSES Quarterly Progress Report No. 4, November 12, 1962–February 12, 1963. E. Janssen and J. A. Kervinen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Mar. 1, 1963. Contract AT(04-3)-189. 21p.

Pressure drop was measured along a $\frac{1}{4}'' \times 1\frac{3}{4}''$ rectangular channel and across two contraction-expansion inserts in a $\frac{1}{2}'' \times 1\frac{3}{4}''$ channel, under both single and two-phase flow conditions. The ratio of two-phase to single-phase loss across the S-1 insert ($B_0/B_1 = 0.4$) appears to be independent of both flow and orientation. It is about 20% below the ratio based on the homogeneous model for the steam and water. The ratio for the S-5 insert ($B_0/B_1 = 0.6$) is in good agreement with the S-1 insert at qualities below 50%. The single-phase friction factor points for the $\frac{1}{4}'' \times 1\frac{3}{4}''$ channel lie about 20% below the Moody smooth pipe curve. The ratio of two-phase to single-phase loss for the $\frac{1}{4}'' \times 1\frac{3}{4}''$ channel shows a flow effect at qualities above 40%, the ratio being higher for lower flows. The points lie everywhere below the Martinelli curve. This is in contrast to the results for the $\frac{1}{2}'' \times 1\frac{3}{4}''$ channel. In the range of channel sizes being considered here, the smaller the hydraulic diameter, the lower the ratio of two-phase to single-phase loss. (auth)

**29070** (NP-12934) ALKALI METALS BOILING AND CONDENSING INVESTIGATIONS. Quarterly Progress Reports 2 and 3, September 31, 1962–March 31, 1963. J. Longo, Jr., ed. (General Electric Co. Spacecraft Dept., Cincinnati). Apr. 20, 1963. Contract NAS 3-2528. 370p.

Activities in a program to obtain two-phase heat transfer data for sodium and potassium under conditions of boiling and condensing are reported. Data obtained during the report period concerning boiling heat transfer are tabulated and evaluated for the 300-kw loop. Information related to pressure drop, flow stability, and pool boiling is discussed. The design and development of the 50- and 100-kw heat transfer loops are reported. Calculations are given for the average boiling heat transfer coefficient, local boiling coefficients for a nonconstant heat input system, 100-kw boiler, condensing coefficients in 300-kw horizontal condenser, and pool boiling. Development of materials for containing the liquid metals is summarized. (N.W.R.)

**29071** (NYO-10427) DRAG ON A BODY IN NEARLY-FREE MOLECULAR FLOW. Marian H. Rose (New York Univ., New York. Courant Inst. of Mathematical Sciences). Apr. 1, 1963. Contract AT(30-1)-1480. 61p. (MF-34)

A linearized Krook equation with the addition of a point source term is used to find the steady flow field in the vicinity of an object in nearly-free molecular flight through a non-ionized gas. The point source is related to the shape of the object and to the boundary conditions both at its surface and at infinity. A knowledge of the flow field and thence of the distribution function near the body permits the drag to be determined as a first order perturbation on the free-molecular value. The cases of a plate and of a sphere

undergoing specular and diffuse reflection, respectively, are worked out in detail. For specular reflection, the drag on a plate is evaluated for all Mach numbers; for diffuse, due to the length of the calculation, only the case of a sphere at high Mach numbers is considered. The results, in both cases, are valid to first order in the Knudsen number. (auth)

**29072** (RT/ING(63)7) HEAT EXCHANGE SIMULATOR. S. Barabaschi, M. Conti, L. Gentilini, and A. Mathis (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio Ingegneria e Servomeccanismi Reattori, Ispra). Mar. 1963. 27p.

An apparatus is described that is intended for electrical analog simulation of the thermal behavior of structures in contact with fluid flows, either when the structure is heat generating or not (for instance fuel elements of heterogeneous reactors, heat exchangers, and etc.). The apparatus is based on a ten channel–ten position commutator, driven by a servomechanism and rotating at a speed proportional to the fluid flow, a series of passive networks, and suitable electronic elements (current generators and isolating amplifiers). It allows an accurate simulation of the phenomena in a simple and relatively cheap way. (auth)

**29073** (TID-17162) EFFECT OF TRANSVERSE MAGNETIC FIELD ON HEAT TRANSFER TO AN ELECTRICALLY CONDUCTING AND THERMAL RADIATING FLUID FLOWING IN A PARALLEL-PLATE CHANNEL. R. Viskanta (Argonne National Lab., Ill.). Aug. 1962. Contract W-31-109-eng-38. 37p. (UAC-6824)

The heat transfer and the temperature distributions for an electrically conducting, thermal-radiation-absorbing and -emitting, viscous, incompressible fluid flowing between two parallel plates in a constant external magnetic field perpendicular to the flow and plates are investigated. Temperature distributions are evaluated for a number of parameters, and calculated heat transfer characteristics are presented. The magnetic field effect is apparently to increase heat transfer by conduction as well as radiation. (D.C.W.)

**29074** (TID-17163) HEAT TRANSFER WITH LAMINAR FLOW IN A CONCENTRIC ANNULUS WITH PRESCRIBED WALL TEMPERATURES. R. Viskanta (Argonne National Lab., Ill.). Aug. 1962. Contract W-31-109-eng-38. 26p. (UAC-6823)

An analysis was performed to determine the heat-transfer characteristics for laminar forced-convection flow in a concentric annulus with prescribed surface temperatures. The temperatures of the inside and outside walls of the annulus are considered to be different. The temperature distributions were determined by utilizing the method of superposition. By way of illustration, numerical results for heat fluxes, mixing cup temperatures, and Nusselt numbers are presented graphically. (auth)

**29075** (TID-18978) BASIC EXPERIMENTAL STUDIES OF BOILING FLUID FLOW AND HEAT TRANSFER AT ELEVATED PRESSURES. Monthly Progress Report for Month of May 1963. Bruce Matzner (Columbia Univ., New York. Engineering Research Labs.). May 31, 1963. Contract AT(30-3)-187. 31p. (MPR-XIII-5-63)

A total of 156 burnout points are reported for vertical upflow of water at 1000 psia inside three different large diameter heater tubes. The test sections investigated were: 0.930 in. inside diameter, 77⅝ in. heated length; 0.504 in. inside diameter, 76 in. heated length; 0.930 in. inside diameter, 24 in. heated length. The ranges of variables covered were: mass velocities from 0.5 to $10.0 \times 10^6$ lb/hr-ft$^2$, burnout heat fluxes as high as $2.5 \times 10^6$ Btu/hr-ft$^2$ and exit conditions from 116°F subcooled to 59% steam quality. Although analysis of the data is still incomplete, two important results are apparent. First, the data appear more orderly when burnout heat flux is plotted against inlet subcooling rather than exit quality. Second, during running of both 0.930 in. inside diameter test sections a region was found in which burnout could be reached by increasing the flow rate which is usually thought of as a safe operation. (auth)

**29076** (TID-18996) HIGH ACCELERATION FIELD HEAT TRANSFER FOR AUXILIARY SPACE NUCLEAR POWER SYSTEMS. Quarterly Technical Report, March 1 to May 31, 1963. H. F. Poppendiek, N. D. Greene, F. R. MacDonald, C. M. Sabin, and R. K. Livett (Geoscience Ltd., Solano Beach, Calif.). Contract AT(04-3)-409. 22p. (GLR-14)

The liquid-metal heat-transfer system was operated with both water and mercury to date. Nonboiling water heat-transfer conductances were found to differ from predicted values by 6 to 15%. A low-power, nonboiling heating experiment was conducted using mercury; heat balances accounting for over 90% of the electrical input were obtained. A radiantly heated boiler test section which will be used for high-quality experiments was constructed and all associated instrumentation procured. Preliminary experiments were conducted of the vaporization of water droplets on a hot surface. A number of materials evaluation studies were made in support of the liquid metal system. Three forced-flow, saturation-boiling heat-transfer models were evaluated and compared. Information on axial boiling conductance variations for different types of vapor-liquid patterns was obtained. Also, one model has yielded data on wall temperature transients in a boiler under slug flow conditions. Analytical studies were made of the vaporization of liquid drops contiguous to a hot wall; droplet lifetimes and thickness of vapor films between the droplet and hot wall were determined. (auth)

**29077** (TRG-Inf-Ser-301) HEAT TRANSFER RESISTANCE OF PIPE BUNDLES ARRANGED IN CHEQUERBOARD ORDER AND WITH CONTINUOUS SPIRAL RIBBING. V. G. Fastovskii and U. V. Petrovskii. Translated by C. A. Routledge (U.K.A.E.A. Reactor Group, Risley Lancs, Eng.) from Teploenerg., No. 6, 69-72(1960). 5p.

The heat transfer and resistance of pipe bundles in checkerboard array were investigated for Al and Cu pipes with continuous spiral ribbing. Equations describing the two phenomena were derived. (auth)

**29078** THE EFFECT OF FINITE CONDUCTIVITY ON THE PROPAGATION OF HYDROMAGNETIC SLOW WAVES. Tosiya Taniuti (Kobe Univ., Japan). J. Math. Anal. Appls., 6: 377-86(June 1963).

The one-dimensional propagation of disturbances in an inviscid conducting fluid of finite magnetic Reynolds number is investigated. The basic equations are not hyperbolic but nevertheless the slow wave has a domain of dependence determined by the sound velocity. (auth)

**29079** MEASUREMENTS OF BURNOUT CONDITIONS FOR FLOW OF BOILING WATER IN VERTICAL ROUND DUCTS. Kurt M. Becker (Aktiebolaget Atomenergi, Studsvik, Sweden). Nukleonik, 5: 138-47(June 1963). (In English)

Results are presented for the first phase of an experimental investigation of burnout conditions for flow of boiling water in vertical round ducts. The results are presented in diagrams where for a certain geometry, the burnout steam qualities, $x_{BO}$, were plotted against the pressure with the surface heat flux as parameter. The

data were correlated by curves. The scatter of the data around the curves was less than ±5%. In the ranges investigated the observed steam quality at burnout, $x_{BO}$, generally decreased with increasing heat flux, increased with increasing pressure, and decreased with increasing mass velocity. The mass velocity effect was explained on the basis of climbing film flow theory. It was found that for engineering purposes the effects of inlet subcooling and channel length are negligible. (auth)

**29080** TEPLO- I MASSOPERENOS. TOM II. (Heat and Mass Transfer. Vol. II). B. M. Smol'skii. Minsk, Publishing House of the Academy of Sciences, 1962. 378p.

Problems of heat and mass transfer during phase and chemical changes are presented. Forty-four papers on critical heat flow in channels of boiling water, physical effects in near-critical regions, optimization of heat transfer apparatus, mechanisms of film boiling, effects of channel geometry on critical heat transfer in forced flow of water, mass transfer in solid-gas and solid-liquid systems, heat convection in gases, heat and mass transfer in annealing processes, analysis of chemical sorption processes, and the thermodynamics of various heat transfer processes are included. (C.E.S.)

**29081** IMPROVEMENTS RELATING TO HEAT EXCHANGERS AND TO THE CLADDING OF FUEL ELEMENTS UTILIZED IN NUCLEAR REACTORS. (to Compagnie Francaise Thomson-Houston). French Patent 1,285,420. Jan. 15, 1962. Filed Jan. 13, 1961.

Heat exchange means forming elements of heat exchangers or the cladding of nuclear fuel elements are formed by two metal sheets welded together by hot rolling. Before the rolling process an appropriate substance is interposed at given zones between said sheets, to prevent the mutual welding of the sheets within said zones. The sheets are then placed between two die halves, each of them provided with cavities. A pressurized fluid is introduced between the sheets at the non-welded zones, to press the sheets into the adjacent die halves, so that they get the desired shape in which they enclose a series of parallel cylindrical cavities. Preferably the outside faces of the sheets are machined before the rolling process to bring them in such a shape that after the deformation between the dies these faces comprise ribs or corrugations improving the heat transfer. (NPO)

**29082** IMPROVEMENTS RELATING TO HEAT EXCHANGERS. (to Compagnie Francaise Thomson-Houston). French Patent 1,285,421. Jan. 15, 1962. Filed Jan. 13, 1961.

Heat exchange means being in contact with a medium from which the heat is to be removed, e.g. in contact with the fissile material in a nuclear reactor, are formed by two metal sheets welded together by hot rolling. Before the rolling process an appropriate substance is interposed at given zones between said sheets, forming a series of parallel stripes. This substance prevents the mutual welding of the sheets within said stripes. The sheets are then placed between a plate and the lower half of a die, while a pressurized fluid is introduced between the sheets at their non-welded zones so that the sheet gets the desired shape. (NPO)

**29083** HEAT EXCHANGER INSTALLATION FOR NUCLEAR POWER PLANT AND METHOD OF HANDLING AND OF MOUNTING THE ELEMENTS OF THAT INSTALLATION. P. Legrand. French Patent 1,288,918. Feb. 19, 1962. Filed Feb. 17, 1961.

To resolve the problems due to the different thermal expansions of different parts of a heat exchanger installation comprising a series of identical vertical elements, these elements are directly mounted on one or several nozzles of the lower header, the whole resting via rollers on a horizontal floor. The upper header, which is the hot fluid entrance header, is connected to each of the tops of the different elements via flexible pipes. For mounting an element into the installation, this element is brought into position by an overhead travelling bridge to which the element is suspended at its top via elastic means e.g. via a spring. (NPO)

## Materials Testing

**29084** (SC-4799(M)) THEORY AND TECHNIQUES OF ENVIRONMENTAL TESTING. (Sandia Corp., Albuquerque, N. Mex.). May 1963. Contract [AT(29-1)-789]. 118p.

Environmental testing theories are discussed and the practices and equipment used in environmental testing at Sandia Corporation are described. (auth)

**29085** (TID-17097) SCINTILLATION SPECTROMETRY. Norman S. Beyer (Argonne National Lab., Ill.). Aug. 1962. Contract [W-31-109-eng-38]. 28p. (UAC-6738).

A review is presented of the use of scintillation spectrometry for testing reactor fuel elements for fuel homogeneity during fabrication. Gamma-ray spectra are given for natural U and U of varying enrichments. The theoretical basis for the gamma-spectrometric determination of $U^{235}$ in fuels is discussed briefly. The procedures used in testing fuel plates and rods for $U^{235}$ distribution are described in some detail. Finally, interpretation of the results is considered. (D.L.C.)

**29086** IMPROVEMENTS IN OR RELATING TO APPARATUS FOR EXAMINING THERMAL CONDUCTIVITY. Arthur Thomas (to United Kingdom Atomic Energy Authority). British Patent 927,555. May 29, 1963. Filed Aug. 20, 1953.

An apparatus for indicating the thermal conductivity of composite bodies, such as reactor fuel elements, is patented. The body to be tested is inserted into a vessel containing a liquid heated to a predetermined temperature. The vessel has a means to detect when the temperature of the liquid has fallen to a lower predetermined temperature and a timer to indicate a certain time interval after the insertion of the body. If the lower temperature is reached before the time interval has elapsed, satisfactory thermal conductivity is indicated. A device to give warning if the body is removed from the vessel before the time interval has elapsed is also included. (M.P.G.)

# GEOLOGY, MINERALOGY, AND METEOROLOGY

**29087** (AEET/AM/31) ESTIMATION OF ZIRCONIUM-95 DEPOSITED BY FALLOUT DURING SEPTEMBER 1961 TO FEBRUARY 1962. R. N. Khandekar and K. G. Vohra (India. Atomic Energy Establishment, Trombay). 1963. 11p.

Data for the deposition of $Zr^{95}$, excluding the contribution of its daughter $Nb^{95}$, after the resumption of nuclear tests in autumn 1961 are presented. The infinity gamma dose from the $Zr^{95}$ deposition for each week is included. The sampling method, chemical procedures, and results are discussed. (auth)

**29088** (RME-4541) RECONNAISSANCE OF THE PERUVIAN COAST FROM LIMA TO TALARA. John W. Gabelman and César Rangel Z. (Division of Raw Materials, AEC). July 1959. 16p.

A geologic and radiometric traverse of about 1,100 kilometers along the Pan American Highway, northward from Lima to Talara, Peru, disclosed no positive evidence of economic uranium deposits. In several isolated areas various rock types have undergone intense hydrothermal alteration, accompanied by replacement deposition of certain metallic and nonmetallic minerals. Some anomalous radioactivity is associated with lower temperature alterations but not with higher temperature alterations. Additional and more detailed examination of lower temperature alteration in the Chiclayo-Guadalupe area seems advisable. (auth)

**29089** (RME-4542) PETROLEUM RESOURCES AND URANIUM POSSIBILITIES OF THE PUCALLPA REGION, LORETO DEPARTMENT, PERU. John W. Gabelman (Division of Raw Materials, AEC). July 1959. 21p.

The geology of the Pucallpa region of Peru is described. The region comprises a portion of the eastern Andean foothills and the plain and isolated uplifts of the Rio Amazonas basin. Petroleum occurrences are described. Results of aerial surveys of surface radioactivity and analysis of water samples from the Ucayali and Pachitea rivers and their tributaries were analyzed for uranium. Factors adversely affecting the possibility of developing profitable uranium deposits are discussed. (C.H.)

**29090** (RME-4549) RECONNAISSANCE OF THE IQUITOS AREA, LORETO DEPARTMENT, PERU. John W. Gabelman and Guillermo Morales S. (Division of Raw Materials, AEC and Peru. Junta de Control de Energia Atomica, Lima). Jan. 1960. 12p.

The Iquitos area on the Ucayali peneplain is the topographically lowest portion of the Río Amazonas basin in Peru and contains the confluence of the great drainage systems of eastern Peru and Ecuador. Swamp and jungle conceal much of the surface which is locally entrenched by rivers whose banks expose fluvial or lacustrine clastics sediments deposited by the river systems prior to slight broad uplift. The beds are slightly tilted, probably from moderate high-angle faulting, and unconformably overlie early to middel Tertiary red coarse clastics deformed during Pliocene uplift of the Andes. The sediments are laterized and may be altered locally by mineralizing solutions. Uniformly very low radioactivity is probably due to strong surficial leaching in the tropical climate. Prospecting by geochemical water sampling is considered possible although anomalies would be extremely small because of strong leaching and dilution. Virtually all the water drained from the eastern Peruvian Andes passes through the Iquitos area. (auth)

**29091** (TID-18953) GEOLOGIC ASPECTS OF THORIUM RECOVERY FROM COMMON ROCKS. Final Report, June 1, 1962 to May 31, 1963. (Rice Univ., Houston, Tex.). For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26]; Subcontract 1491. 16p.

The distribution of thorium and uranium in the Conway granite of New Hampshire was investigated by autoradiography and alpha-particle pulse-height analysis. The concentration of thorium is at least four times the average concentration of thorium in the earth's crust. Alpha-particle pulse-height analysis was also used to study radioactive disequilibrium in the uranium-238 decay series. (N.W.R.)

**29092** (UCRL-7316) THE TENSOR CODE. G. Maenchen and S. Sack (California. Univ., Livermore. Lawrence Radiation Lab.). Apr. 9, 1963. Contract W-7405-eng-48. 34p.

The program, TENSOR, for the calculation of underground explosion phenomena and other time dependent problems involving the motion of elastic, plastic, fractured, and fluid materials is discussed. The method used in the code allows treatment of transient phenomena in two space dimensions (cartesian or axial symmetry), and is particularly appropriate for problems involving compressible flow, large displacements, and free transitions of material between the elastic, cracked, plastic, and fluid states. The equations of motion are a straightforward generalization (to include a stress tensor) of conventional Lagrangian techniques for compressible flow and shock hydrodynamics problems. Methods for defining the stress system are discussed, and examples are included. (auth)

**29093** (AEC-tr-5871) VERTICAL DISTRIBUTION OF RADIOACTIVITY IN CLOUD ELEMENTS. V. Yu. (Iu.) Potsius. Translated for Los Alamos Scientific Lab., N. Mex. from Mokslinial Pranesimai, Lietuvos TSR Mokslu Akad., Geol. ir Geograf. Inst., 11: 73-80(1960). 9p.

The vertical distribution of the radioactivity of cloud elements was obtained, with maxima at the center and near the base of the cloud. An empirical equation was fitted, describing the radioactivity of cloud elements at the center of the cloud. It was found that intense radioactivation of droplets sets in at a height of 300 meters above the base of the cloud when $r_m = 9$ microns in the zone of gravitational coagulation of cloud droplets. An explanation is furnished for the high radioactivity near the base of the cloud. The mean radioactivity of an individual cloud droplet is of the order of $10^{-3}$ alpha tracks. The radioactivity of a droplet depends on the latter's radius and location within the cloud. The order of magnitude of the radioactivity of cloud elements is the same as that of raindrops. (auth)

**29094** (AEC-tr-5891) QUANTITATIVE MEASUREMENTS OF CLOUD ELEMENT RADIOACTIVITY. V. Yu. (Iu.) Potsius. Translated for Los Alamos Scientific Lab., N. Mex. from Mokslinial Pranesimai, Lietuvos TSR Mokslu Akad., Geol. ir Geograf. Inst., 11: 48-68(1960). 22p.

A method is outlined for calculating the concentration of radioactive substances in cloud elements from their alpha tracks in a nuclear emulsion. Computational formulas were derived for the concentration of the radioactive elements of three radioactive families. The concentrations of radioactive substances and the radioactivity in cloud elements were calculated. The radioactivity of cloud elements is of the same order of magnitude as in precipitation. The possibility that the radioactivity of precipitation may

change as it falls to earth is mentioned. Radioactivity in cloud elements is due principally to products of emanation origin ($4.9 \times 10^{-11}$ C per gram $H_2O$). The radioactivity of nonemanation radioactive elements is $4.6 \times 10^{-13}$ C per gram $H_2O$. Reference is made to the possible presence of $U^{235}$ atoms of artificial origin in the droplets. A cloud accumulates radioactive substances, which are captured by the cloud's droplets. The coefficient of accumulation, $\epsilon = 1000$, is cited for determining the radioactive substances in a cloud. (auth)

**29095** SYNTHETIC HYDROXY APATITE CRYSTALS. II. AGING AND STRONTIUM INCORPORATION. W. F. Neuman, R. Bjornerstedt, and B. J. Mulryan (Univ. of Rochester, N. Y.). Arch. Biochem. Biophys., 101: 215-24 (May 1963).

The process of crystal aging in synthetic apatites was studied in detail. It is shown that aging involves two different processes: a successive transport of calcium to fill out vacancies in the crystal interior, and a decrease in specific surface area probably due to recrystallization. As a consequence of these processes, the Ca/P ratio rises from 1 to 1.66 over a period of about 2 days. The hydration shell decreases 20% also in the first 2 days and continues to decrease somewhat further. It is also shown that the uptake of strontium may be preferentially limited to column positions and that calcium discriminates against strontium in this process. Crystal aging can then be expected to decrease the amount of exchangeable strontium and to increase the Ca/Sr discrimination. There is reason to believe that the property of internal crystal rearrangement occurs in bone mineral. Since Ca/Sr discrimination in vivo is observed to be less than expected, the present findings tentatively support the idea of a living membrane separating the bone mineral from the circulating fluids, this membrane performing an active transportation function that distinguishes between calcium and strontium. (auth)

**29096** DISTRIBUTION OF RADIOACTIVITY IN SOME IGNEOUS ROCKS OF TUSCANY. S. Borsi, A. Longinelli, and E. Polacco-Milani (CNEN, Rome). Atti Soc. Toscana Sci. Nat. Pisa, Proc. Verbali Mem., Ser. A, No. 2, 3-22 (1962). (RT/GEO(63)8). (In Italian)

The distribution of radioactivity in seven samples from magmatic rocks of Tuscany was studied by means of the nuclear plates method. Two of the samples studied came from a quartzmonzonite near Gavorrano (Grosseto); the other samples came from two different ignimbrite flows near Roccastrada (Grosseto) and near S. Vincenzo (Livorno). The results obtained are tabulated. It was concluded that the phenocrysts of fundamental minerals from ignimbrites (quartz, sanidine, plagioclase, biotite) show values of the $\alpha$ specific activity within the range of the values of the same minerals from intrusive rocks of similar composition. This is quite normal since the rocks have a period of their genetic history similar to that of intrusive rocks. The ignimbrites studied have different degrees of porosity. There is an inverse relation between the porosity of the rock and its specific activity. Probably this means a higher degree of uranium solubility when the mass of the rock is more penetrable. The $\alpha$-activities of the ignimbrites are lower than those of intrusive rocks of similar chemical composition. This does not depend upon the number of accessory minerals whose activity has been separated from that of the fundamental minerals and of the vitreous mass. This is a confirmation of uranium loss in this type of eruptive rocks during the eruption itself and the consolidation process. (auth)

**29097** SYSTEMATIC HYDROLOGICAL SURVEILLANCE. P. Bovard and A. Grauby. Bull. Inform. Sci. Tech. (Paris) No. 70, 45-53(Mar. 1963). (In French)

The objects of systematic hydrological surveillance are outlined and the sampling and measurement stages of a continuous control are presented. A detailed study of the different materials used, shows the diversity of the measuring techniques of a station. For each of these techniques, the type of counter actually available commercially in France is described with its shortcomings and its possibilities. This study was completed by the practical realization of a hydrological station, based on continuous triple control. Mobile stations, in particular those intended for maritime and river control, are being developed. An efficient control is shown to require both a preliminary hydrological study before choosing the station site and a judicious choice of the apparatus depending on the characteristics of the effluents to be controlled. (auth)

**29098** GEOCHEMISTRY OF WATERS AT THE URANIUM PROSPECT AT UMRA, RAJASTHAN. V. V. S. S. Tilak (Andhra Univ., Waltair, India). Current Sci. (India), 31: 509-10(Dec. 1962).

The concentrations of uranium, nickel, cobalt, copper, vanadium, calcium, sodium, and potassium in the natural waters were determined and their distribution patterns interpreted in the light of the geology of the area. The climatic and hydrological conditions prevalent there and the geochemical behavior of the elements were also considered. (TCO)

**29099** ON THE DIFFUSION OF RADIOGENIC ARGON FROM MINERALS. E. K. Gerling, L. K. Levski, and I. M. Morozova (Laboratory of Geology of the Precambrian, Leningrad). Geokhimiya, No. 6, 539-43(June 1963). (In Russian)

A method is described for determining the activation energy of radiogenic gas emanation from minerals by the study of a property change of the object at a continuous temperature rise with a constant rate, the so-called "tempering" method. The investigations are carried out on microcline perthite and biotite. In case of microcline-perthite a spectrum of activation energy of radiogenic Ar emanation with an energy maximum of 32,000, 46,000, 100,000 cal/mol is detected. The spectrum of biotite activation energy is characterized by maximum values of activation energy of 33,000, 48,000, 69,000 cal/mol. For biotites, the activation energy is 36,000 cal/mol, 460,000 cal/mol, and 71,000 cal/mol respectively. The techniques of the experiments and the advantages of the proposed method are described. (auth)

**29100** DIFFUSION OF HELIUM FROM STONY METEORITES. L. K. Levski (Laboratory of Geology of the Precambrian, Leningrad). Geokhimiya, No. 6, 544-8(June 1963). (In Russian)

A new method for the determination of the activation energy of inert gas isolation in stony meteorites is proposed. The method is based on an even temperature rise of the sample. Results of the experiment are investigated in terms of the theory of defect annealing in crystals. The activation energy values of helium in the meteorites Staroye Pesyanoye and Zhovtnevy Khutor are determined as 20,000 ± 1000 cal/mol and 30,000 ± 3000 cal/mol respectively. (auth)

**29101** XENON ISOTOPES IN MONAZITES. Yu. A. Shukolyukov (Laboratory of Geology of the Precambrian, Leningrad). Geokhimiya, No. 6, 549-51(June 1963). (In Russian)

The isotopic composition of xenon of 7 monazites (weight-

sample 3 to 5 g) from pegmatites of an age of $2 \times 10^9$ years was measured. 92 to 97% of xenon have formed at the expense of spontaneous fission of $U^{238}$. The share of xenon in the neutron-induced fission of $U^{235}$ is noticeably less than in uraninites from the same formations. This is caused by the absorption of a part of the neutron flux by rare earths. (auth)

**29102** URANIUM AND THORIUM IN HYDROTHERMAL ALTERED ROCKS OF KZYL-OMPUL (NORTHERN TIAN SHAN). L. L. Leonova (Vernadskii Inst. of Geochemistry, Moscow). Geokhimiya, No. 6, 552-6(June 1963). (In Russian)

The low-temperature hydrothermal process of rock alteration of the Kzyl-Ompul massif is accompanied by a supply of uranium and thorium, the hydrothermal solutions with a heightened uranium concentration probably genetically being connected with leucocratic granites and the solutions with a heightened thorium content with syenites. (auth)

**29103** CONCENTRATION OF RADON AND THORON IN THE AIR ABOVE THE ATLANTIC OCEAN. RADIOACTIVE EQUILIBRIUM BETWEEN THESE GASES AND THEIR DESCENDANTS. Jacques Fontan (Centre de Physique Nucleaire, Toulouse), Daniel Blanc, André Bouville, and Gerard Lambert. J. Phys., 24: 165-6 (Feb. 1963). (In French)

Measurements of the concentration of Rn and Tn were made from May 28 to June 28, 1962, aboard the meteorological ship France II, anchored at 45° latitude N and 16° longitude E. The concentrations of the radioactive decay products of Rn and Tn were measured at the same time to study the radioactive equilibrium between Rn and its descendants in the air above the Atlantic Ocean and to determine the variation of the concentrations as a function of the meteorological conditions. The sampling technique is described. The Tn activity and the ThB and ThC activities remained below $5.5 \times 10^{-15}$ C/l of air. The radioactive equilibrium of Rn and its descendants remained constant at 5.3, dependent of the wind velocity. The concentration of Rn, however, seemed to be quite dependent on meteorological factors. (J.S.R.)

**29104** CONTAMINATION OF LEAVES BY RADIOACTIVE FALL-OUT. Noboru Yamagata (Inst. of Public Health, Tokyo). Nature, 198: 1220-1(June 22, 1963).

Measurements were made on the concentrations of $I^{131}$ and $Zr\text{-}Nb^{95}$ in daily samples of dust and in spinach twice a week from the market from Sept. 12 to Nov. 14, 1962. The averages are 0.48 and 0.54 $\mu\mu c$ of $I^{131}$ and 0.75 and 2.2 $\mu\mu c$ of $Zr\text{-}Nb^{95}$ in 1 $m^3$ air and 1 g fresh spinach, respectively. An exponential equation was assumed for the foliar contamination in terms of the concentration in air, and the retention factor and exposure time are calculated to be 0.10 and ≥35 days, respectively. The $Cs^{137}$ foliar contamination is estimated to be 0.035 to 0.046 $\mu\mu c$/g fresh. (D.L.C.)

**29105** RADIOACTIVITY OF SODIUM CARBONATE LAVA FROM OLDOINYO LENGAI, TANGANYIKA. J. H. J. Poole (Trinity Coll., Dublin). Nature, 198: 1291(June 29, 1963).

The U and Th contents in carbonate lava from the active volcano Oldoinyo Lengai in Tanganyika were determined by α-ray and γ-ray emission. The results obtained were: Th content = 4.3 ppm and U content = 34.5 ppm. A comparison of the γ spectrum with that of uraninite shows that the U and Ra in the lava are in radioactive equilibrium. No explanation is offered for the high U and low Th contents. (D.L.C.)

**29106** STUDIES IN RADIOACTIVE FALLOUT IN NEW ZEALAND. PART 2. THE TOTAL BETA ACTIVITY OF RAINWATER (SEPTEMBER 1956–JUNE 1959). G. S. McNaughton. New Zealand J. Sci., 5: 198-220(June 1962).

From monthly rainwater samples collected at six New Zealand sites from September 1956 to June 1959, the decay rate of the total β activity was measured. By comparison of this rate with the rate of decay of the slow neutron fission products of $U^{235}$, an estimate was made of the month in which the fission products in each sample were formed. From the relative ages of successive samples, it was concluded that about ten successive waves of fresher fission product activity were deposited in the rainwater over the two-year period. Possible nuclear test series which caused these waves are suggested. A greatly increased amount of short-lived radioactive material was deposited in the north of New Zealand after the U.K. test series in Australia in 1957, although the U.K. Pacific tests in May contributed most of the total β activity in the latter half of 1957. The next major influxes of debris came from the latter half of 1958 from U.S. and U.K. Pacific tests. The relative aging of the 1959 samples is supported by $Sr^{90}$ and $Ce^{144}$ determinations. It is possible that some U.S.S.R. October 1958 debris was detected in March–June 1959. If this deduction is valid, upper limits of 25% and 9% have been calculated for the $Sr^{90}$ deposition at Auckland (37°S) from this source during the period January–June 1959, depending on whether data for thermal fission of $U^{235}$, or for 14-Mev fission of $U^{238}$ are used. The estimated upper limits for Russian $Sr^{90}$ deposited at Wellington (41°S) in the same period is probably not more than ⅔ of this. The accumulated deposition of total β activity over the two-year period was approximately proportional to the amount of rainfall at the collection site, although there was a decrease of 35% in the specific activity of the rain from the most northerly site to that furthest south. Age measurements suggest that this might be due in part to the longer time taken for the debris to travel further south, rather than solely due to a dilution phenomenon. (auth)

**29107** CONCERNING THE SERVICEABILITY OF A $C^{14}$-AGE-DETERMINATION APPARATUS. Heinz Felber. Oesterr. Akad. Wiss., Math. Naturw. Kl., Sitzber., Abt. II, 170: 85-103(1962). (In German)

A discussion of the principal influences of the statistical regularity of radioactive decay on age determination according to the radiocarbon method led to the preparation of graphs of the relative uncertainty in age determination depending on probe age. The existence of an age limit for an age-determination apparatus was shown and the constant for the pertinent relative age uncertainty was found. The influence of measuring time on age determination on the energy discrimination as well as a method for systematic estimation, is discussed. The possibility of comparing the serviceability of two apparatuses is considered. (tr-auth)

**29108** MEASUREMENT ARRANGEMENT FOR ENERGY-POOR β-RADIATION OF LOW INTENSITY ESPECIALLY FOR THE AGE DETERMINATION ACCORDING TO THE RADIOCARBON METHOD. H. Felber and P. Vychytil. Oesterr. Akad. Wiss., Math. Naturw. Kl., Sitzber., Abt. II, 170: 179-205(1962). (In German)

The principles and methods of age determination according to the radiocarbon method are reviewed. The construction of a measuring arrangement for energy-poor radiation of low intensity causing an extensive reduction in the background effect is discussed. The counter, shielding, and electronic equipment are described. The efficiency of the apparatus was determined. (M.C.G.)

**29109** RHODIUM-102 FALLOUT: VARIATIONS IN DEPOSITION AND CONCENTRATIONS IN PRECIPITATION. M. W. M. Leo and A. Walton (Isotopes, Inc., Westwood, N. J.). Science, 140: 1398-1400(June 28, 1963).

Rhodium-102 was produced as a tracer for U.S. high-altitude detonations in August 1958 and has been detected and monitored in precipitation since October 1960. Between January and September 1961, when atmospheric tests were resumed, the contribution of this high-altitude debris in fallout increased. (auth)

**29110** ISOTOPIC ANALYSIS OF URANIUM AND SULFUR IN THE STUDY OF THE MINERALIZATION OF CANALE MONTERANO. L. Ancarani and C. Bettinali (CNRN, Rome). Studi Ric. Div. Geomineraria, Comit. Nazl. Ric. Nucl., 3: 455-74(1960). (RT/GEO(63)9). (In Italian)

The $U^{234}/U^{238}$ isotopic ratios of water soluble uranium from leaching of volcanic tuffs of Canale Monterano were investigated. A $U^{234}$ enrichment was observed. The isotopic ratios of sulfur of iron sulfides in tuff mineralized with uranium and in the pyrites deposits forming the bed of the uranium mineralization were measured. A correlation of the isotopic ratios and of the data of statistical analysis of 334 uranium determinations of the mineralization show the existence of 3 logonormal families. (auth)

**29111** BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 30, JULY-SEPTEMBER, 1962. Tokyo, The Japan Meteorological Agency, 1963. 98p. (In English and Japanese)

Results from measurements of atmospheric radioactivity in various cities in Japan from July to Sept. 1962, using rain water and dust, are tabulated. (P.C.H.)

**29112** URAN V DREVNIKY KONFLOMERATAKY. (Uranium in Ancient Conglomerations). A. I. Bezgubov, Yu. I. Byvshikh, P. K. Dement'ev, et al. Moscow, State Publishing House of Atomic Science and Technology, 1963. 188p.

Generalized information on uranium deposits associated with conglomerations is presented. The two main ore regions, Witwatersrand in South Africa and Blind River in Canada, are considered in detail. The stratigraphy of ore deposits, the location of minerals, and the relation to petrology are discussed. The geology and mineralogy of the Jacobina Area in Brazil, and deposits in Ghana, Australia, Finland, and the Gabon Republic are also considered. (C.E.S.)

**29113** METHOD OF AND APPARATUS FOR RADIOACTIVITY WELL LOGGING. Robert K. Swanson, Charles E. Jameson, and George W. Dingus. U. S. Patent 3,090,867. May 21, 1963. Filed Oct. 14, 1957.

A method and apparatus to determine the presence of gas and oil in a substrata reservoir by radioactive means is patented. Formations adjacent to a bore hole are irradiated with neutrons, and the $\gamma$ rays generated by the neutron bombardment are detected and recorded. Two energy ranges of $\gamma$ rays are detected, one above 1.5 Mev and the other above at least 4 Mev. A comparison of the energy levels detected permits exact identification of the substrata formations. Methods of identification and the circuitry are described in detail. (M.P.G.)

**29114** SUBSURFACE EXPLORATION. Alexander S. McKay (to Texaco Inc.). U. S. Patent 3,096,439. July 2, 1963. Filed Dec. 12, 1958.

A method and apparatus for measuring the permeability of the earth's formations traversed by a borehole are described. Concentric pipes (the outer one or ones being several feet shorter) are lowered into the hole, and fluids are pumped through them. The fluid in one pipe contains a substance that becomes radioactive on exposure to a thermal neutron source lowered into the well. A radiation detector lowered into the well monitors the position of interface (or interfaces) formed between the fluids as their relative flow rates are varied. Thus, a profile of the permeability is obtained without handling radioactive substances. (D.C.W.)

**29115** OVERHAUSER EFFECT WELL LOGGING. Edward H. Poindexter and Henry C. Torrey (to California Research Corp.). U. S. Patent 3,096,476. July 2, 1963. Filed Sept. 2, 1958.

A method by which hydrogenous fluids in earth formations can be detected and identified as water or hydrocarbons is proposed. Nuclear magnetism well logging is carried out to polarize hydrogen nuclei present in $H_2O$ or hydrocarbons, and nuclear magnetic precessional signals from the protons in the nuclei are detected. Polarization is repeated, and the earth is irradiated with an electromagnetic field capable of resonance with precessing electrons associated with crude oil hydrogen nuclei. Resonance would appear as a change in the detected nuclear magnetic signal. Equipment to be used in such logging is described. (D.C.W.)

# HEALTH AND SAFETY

*Refer also to abstracts 28639 and 29731.*

**29116** (A/AC.82/G/L.769) ASSAY OF STRONTIUM-90 IN HUMAN BONE IN NORWAY, 1956-1961. Arve Kjelberg, Eivind Kvale, Anton Fr. Olsen, Alexis C. Pappas, and Jorolf Alstad (Oslo. Universitetet). 12p.

Results are reported from the analysis of human bone samples collected in Norway from 1956 to 1961 for $Sr^{90}$. The analytical method is described and results are tabulated by age and district. (C.H.)

**29117** (HW-67293) MONITOR FOR MIXED-FISSION PRODUCT CONTAMINATION ON FACE MASKS. M. O. Rankin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 8, 1960. Contract AT(45-1)-1350. 7p.

The air mask monitor was designed to utilize scintillation detection methods for mixed fission products to obtain operational reliability and good counting statistics. Each washed mask is monitored for one minute. Contaminated masks will be rejected in less than one minute with the exact time being a function of the amount of contamination and the desired rejection level. (auth)

**29118** (HW-76526) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD FOR 1962. R. H. Wilson, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 25, 1963. Contract AT(45-1)-1350. 190p.

An evaluation of results obtained from the Hanford environmental surveillance program for 1962 indicates that most of the environmental radiation exposure for the majority of persons in the neighborhood of the Hanford project was due to natural sources and world-wide fallout rather than to Hanford operations. Neutron-induced radionuclides present in reactor cooling water discharged to the Columbia River continued to be the source of greatest potential exposure to the people in the environs. The primary mechanisms of exposure from this source are drinking of sanitary water derived from the Columbia River and the consumption of fish and waterfowl which inhabit the river. Data are presented on radioactive materials in Columbia River water, sanitary water, fish and waterfowl, marine organisms, the atmosphere, milk and agricultural products, and the concentration of $I^{131}$ in beef cattle thyroid glands. (C.H.)

**29119** (HW-SA-3056) DETERMINATION OF RIVER DISPERSION FACTORS. G. E. Backman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 24, 1963. Contract AT(45-1)-1350. 20p.

Three dye tests were conducted in an effort to trace the liquid effluent dispersion pattern from the plutonium Recycle Test Reactor in the Columbia River. Results show that near-complete dispersion of liquid effluent discharged into the river at 300 Area will take place by the time the river flow reaches the Pasco Pumping Station but complete dispersion does not take place by the time the effluent reaches the proposed Richland Pumping Station location. (C.H.)

**29120** (MRL-TDR-62-61) NUCLEAR RADIATION GUIDE. (Aerospace Medical Div. 6570th Aerospace Medical Research Lab., Wright-Patterson AFB, Ohio). Nov. 1962. 233p.

Supersedes WADC Technical Report 57-118 (I and II) "A Radiobiology Guide."

Information about nuclear radiation is presented and discussed in terms of the average layman to acquaint personnel not specifically trained in the area with the problems involved in radiological protection and as an aid to understanding this relatively new science. The following topics are treated: basic nuclear physics, biological effects of radiation, shielding methods, monitoring instruments, medical evaluation of personnel, radiation exposure control, shipment of radioactive materials, waste disposal, and radiation protection guides. People involved in this type of work will find it useful as a handy reference and as a refresher. The guide is not a complete treatise on the subject, but an extensive bibliography of additional sources is included for more advanced work in the area. (auth)

**29121** (NP-12762) DESIGN AND REVIEW OF STRUCTURES FOR PROTECTION FROM FALLOUT GAMMA RADIATION. (Office of Civil Defense, Washington, D. C.). Revised, Oct. 1, 1961. 117p.

The formation, distribution, and biological effects of fallout are reviewed. Design features of structures for protection against fallout $\gamma$ radiation are described. Factors affecting $\gamma$ dose rate, shielding geometry, special shielding problems, and ventilation in shelters are discussed. Calculations are presented of the $\gamma$ dose from fallout for simple underground shelters, simple aboveground shelters, basement shelters, upper-story shelters, and compartmentalized structures. Charts for use in shielding calculations are included. (C.H.)

**29122** (NP-12949) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 1, No. 6. (Canada. Dept. of National Health and Welfare. Radiation Protection Div., Ottawa). June 1963. 39p. (In English and French)

Data are presented on radioactivity in samples of air, precipitation, and milk collected in Canada during April, 1963. Data are also included on reactor environment monitoring, personnel dosimetry, isotope safety assessments, and field investigations of radiation safety. (C.H.)

**29123** (ORNL-TM-612) THE AUDITING OF REACTOR SAFETY AT THE OAK RIDGE NATIONAL LABORATORY. Francois Kertesz (Oak Ridge National Lab., Tenn.). July 8, 1963. Contract [W-7405-eng-26]. 19p.

A number of special committees and supervisory groups are involved in the approval-granting process of reactors and reactor experiments. The relationship of these groups, their scope, and method of operation are described. (auth)

**29124** (ORO-491) A SENSITIVE TRITIUM MONITOR. Final Report. Lewis F. Ballard and R. L. Ely, Jr. (Research Triangle Inst., Durham, N. C. Isotope Development Lab.). May 31, 1963. Contract AT(40-1)-2513. 39p. (RTI-2513-T10)

The tritium monitor is composed of seven parts: a dehumidifier, a source of counting gas, a vapor chamber, a Geiger counter, a ratemeter including a power supply and alarm system, a recorder, and a vaporizer. The dehumidifier extracts moisture from the air. This water then goes into the vapor chamber which is composed of a gas purging section and a sample section. In the purge section, the counting gas is bubbled through the water to remove dissolved gases. The water then enters the sample section where a second stream of counting gas flows over the water and becomes saturated with water vapor at the chamber temperature. The mixture then flows through a heated Geiger counter where the tritium is counted. The pulses

are registered by the ratemeter from which a signal is fed to the recorder. The ratemeter is equipped with an upper and lower alarm circuit. When either of these is triggered, the external alarm circuit is activated. Although the ratemeter remains locked in alarm position until the release button is pushed, the recorder continues to record the actual count rate. Because the water is condensed from the air, the sensitivity of the instrument is somewhat dependent upon the relative humidity. However, for its purpose as a monitor, this variation in sensitivity is not serious for normal variations in laboratory relative humidity. A vaporizer is provided for returning sample overflow to the atmosphere. (auth)

**29125** (SCPRI(A)-87) APPLICATION DES REGLES DE LA NORME FRANCAISE C 15-160 EN MATIERE DE RADIOPROTECTION (RADIODIAGNOSTIC MEDICAL). (Application of the Regulations of French Norme C 15-160 in Matters of Radioprotection (Medical Radiodiagnosis)). (France. Service Central de Protection contre les Rayonnements Ionisants, Paris). Apr. 1963. 8p.

Discussions and examples are given to exemplify the application of rules governing the shielding and uses of medical radiodiagnostic equipment. (T.F.H.)

**29126** (TID-17120) GAMMA-RAY DOSE FROM SHORT-LIVED FISSION PRODUCTS FROM NUCLEAR WEAPON TESTS. Philip F. Gustafson (Argonne National Lab., Ill.). July 1962. Contract W-31-109-eng-38. 16p. (UAC-6705)

The factors involved in the deposition of short-lived fission products and $Cs^{137}$ on the ground from nuclear tests are discussed. Gamma-ray doses were calculated from soil measurements for the following nuclear test situations: (1) injection into the low polar stratosphere (Soviet Oct. 1958); (2) injection into low equatorial stratosphere (Hardtack I); and (3) high-altitude detonation (Orange and Teak). Integral doses were calculated for 1-, 30-, and 70-year intervals. Calculations were also made for the Soviet 1961 tests, and it is seen that considerable holdup at high altitude occurred. (D.L.C.)

**29127** (TID-18624) STUDY OF A LARGE-VOLUME IMPACTOR FOR HIGH-ALTITUDE AEROSOL COLLECTION. Report No. 2391. A. R. McFarland and H. W. Zeller (General Mills, Inc., St. Paul). Apr. 1, 1963. Contract AT(11-1)-401. 100p.

An experimental investigation was conducted to determine the performance characteristics of a multiple-jet impactor for sampling stratospheric aerosols at altitudes between 100,000 and 150,000 ft. Tests were made at pressures of 1 to 15 mm Hg and with aerosols of 0.055, 0.081, and 0.125 microns diameter. Primary variables studied included impaction parameter, jet Reynolds number, clearance ratio, and surface treatment. Data were obtained for a single jet impactor with the same nozzle shape as that of the multiple jet impactor. Results showed that the impaction efficiency decreased with jet Reynolds number for values of the Reynolds number between 18 and 100, whereas it was essentially constant for Reynolds numbers greater than 100. Collection efficiency was investigated at three clearance ratios: 0.34, 0.53, and 1.0. It increased with decreasing clearance ratio, and the impactor's cutoff characteristics were sharper at the lower clearance-ratio values. Results comparing oil-coated with uncoated collectors showed that maximum efficiency can be obtained with uncoated surfaces only at relatively low velocities. For 0.081-micron diameter particles and an impaction parameter of 0.192, the particles began to bounce off clean metal surfaces at jet velocities between 3000 and 4000 cm/sec. Comparisons were made between the performance of the multiple-jet impactor and that of single-jet impactors reported by other investigators. (auth)

**29128** (UCLA-513) NOTES OF THE DEPOSITION OF FALLOUT IN RELATION TO TOPOGRAPHY AND LOCAL METEOROLOGICAL CONDITIONS. William E. Martin (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). June 1963. Contract AT-04-1-GEN-12. 16p.

Activities in a program to collect radioactive effluents released during the test operation of a Kiwi reactor (Kiwi B-1a) on December 7, 1961, are reported. Granular fallout collectors and cheesecloth aerosol collectors were prelocated along roads approximating arcs of 5, 16, and 37 miles from the reactor test cell at the Nevada Test Site. Each of these arcs crossed successively lower and wider parts of a gently sloping valley. A last-minute shift in wind direction carried the effluent cloud away from the prelocated sampling devices. Apparently, the cloud was trapped until nightfall in an inversion layer from 2000 to 3500 feet above the surface. During the night following the reactor test, tropospheric or stratospheric fallout probably derived from nuclear detonations in the U.S.S.R. (but no short-lived fission products) were deposited on the above-mentioned sampling devices. The shallow-valley inversion and cold air drainage caused the pattern of this deposition to be closely related to the local topography. The beta-gamma activity deposited on samplers at low elevation (presumably below the valley inversion layer) was less than that deposited on samplers at higher eleveations. The highest levels of beta-gamma activity were detected on samplers which had been located direcly in the most probable pathway of nocturnal cold-air drainage. Further studies are recommended. (auth)

**29129** (UCRL-7254) HAZARDS CONTROL QUARTERLY REPORT NO. 11, OCTOBER–DECEMBER 1962. (California. Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 51p.

Progress in hazards control is reported in eleven papers. Separate abstracts were prepared for eight papers. Topics not covered by separate abstracts include: cyanogen interference in hydrogen cyanide detector tubes, burning of fire-retardant absorbent paper on exposure to boiling perchloric acid, and high-pressure Bourdon tube failure. (M.C.G.)

**29130** (UCRL-7254(p.1-6)) EYE PROTECTION FOR ELECTROMAGNETIC RADIATION FROM FURNACES. D. E. Jones, W. Van Sandt, et al. (California. Univ., Livermore. Lawrence Radiation Lab.).

Protection of the eyes from electromagnetic radiation emitted by high-temperature furnaces is discussed. An approach is shown to consist of tabulating the blackbody spectral distribution of energies for one or more typical sets of conditions. This tabulation may then be compared with physiologically acceptable radiation intensities to obtain the eye protection requirements. A blackbody model and simplifying approximations are used. An example presented indicated the desirability of knowing the spectral transmission characteristics of filter glasses. (M.C.G.)

**29131** (UCRL-7254(p.6-16)) SAFETY CONSIDERATIONS OF LASERS. M. Sykos (California. Univ., Livermore. Lawrence Radiation Lab.). (UCRL-7193)

Hazards in the use of lasers are discussed. Uses of lasers in welding, communications, machining, medicine, photography, and defense are outlined. Hazards from the

beam, light source, power supply, and coolants are described for both ruby and gas lasers. (M.C.G.)

**29132** (UCRL-7254(p.16-27)) SURFACE COLLECTION EFFICIENCY OF LARGE-PORE MEMBRANE FILTERS. C. L. Lindeken, K. F. Petrock, et al. (California. Univ., Livermore. Lawrence Radiation Lab.). (UCRL-7179)

The surface collection efficiency of membrane filters with pore diameters up to 10 μ was tested. Evaluation consisted of collecting airborne radon daughter products on the filter and measuring the energy resolution of the 7.68-Mev $Po^{214}$ activity. Membrane filters are porous, dry gels of cellulose esters. Filter resistance to air flow was measured. Results are presented in graph form. (M.C.G.)

**29133** (UCRL-6254(p.27-31)) THERMOLUMINESCENT RADIATION DOSIMETRY. W. A. Phillips, A. Forsman, et al. (California. Univ., Livermore. Lawrence Radiation Lab.).

A thermoluminescent dosimeter and heater package was developed. Preliminary tests showed that a dose of 1000 r of gamma radiation can be read and that 20 mr above background can be easily distinguished. (M.C.G.)

**29134** (UCRL-7254(p.32-4)) A NEW WEATHER CAP DESIGN FOR USE IN EXHAUST VENTILATION SYSTEMS. J. J. Cohen and K. K. Butterfield (California. Univ., Livermore. Lawrence Radiation Lab.).

A design is presented for a weather cap for ventilation exhausts that gives effective prevention against infiltration of rain water and low resistance to air flow. It allows high-level vertical exhaust of potentially hazardous contaminants from the ventilation system compared to horizontal discharge from other caps. (M.C.G.)

**29135** (UCRL-7254(p.34-9)) HYDRAULIC PRESS FOR LOW-LEVEL RADIOACTIVE SOLID WASTE. R. D. Taylor, D. J. Kvam, and F. S. Smith (California. Univ., Livermore. Lawrence Radiation Lab.).

A press for compression of low-level radioactive solid waste packaged in 55-gallon drums is described. The press consists of a power unit, a hydraulic cylinder, a press plate, a base plate, a control panel, I-beam structural supports, and steel-plate platforms. In the disposal of 1000 radioactively contaminated 5-gallon glass carboys and metal secondary containers, after crushing they were placed in 35 drums. (M.C.G.)

**29136** (UCRL-7254(p.39-42)) TESTING OF RESPIRATOR HIGH-EFFICIENCY PARTICULATE FILTER CARTRIDGES FOR REUSE. J. J. Cohen and W. Nettleton (California. Univ., Livermore. Lawrence Radiation Lab.).

Criteria were established for reuse of high-efficiency particulate filter cartridges for half-mask respirators. An apparatus for determining resistance to normal breathing was constructed using the "giraffe" sampler that can maintain a desired air flow through a filter cartridge despite the resistance. It was observed that resistance did not materially increase with use. (auth)

**29137** (UCRL-7254(p.43-5)) THE EFFECT OF SEALERS ON GROUND-WATER PERMEATION OF ON-GRADE CONCRETE. J. R. Gaskill and C. R. Veith (California. Univ., Livermore. Lawrence Radiation Lab.).

To obviate the ground-water leaching effects on concrete slabs laid without an impervious membrane placed between the drainage pad and the concrete, a search was made for water-repellent concrete sealers. A silicone resin dissolved in a hydrocarbon vehicle, a water solution of an alkaline phosphate, and a pigmented polyamide-cured epoxy floor enamel were tested. All of the sealers were beneficial in preventing water permeation and the breaking of the concrete-adhesive bond. However, the best system consisted of one coat of dilute epoxy plus one coat of undiluted epoxy. (M.C.G.)

**29138** (USNRDL-TR-639) SOME RELATIONSHIPS AMONG PARTICLE SIZE, MASS LEVEL AND RADIATION INTENSITY OF FALLOUT FROM A LAND SURFACE NUCLEAR DETONATION. D. E. Clark, Jr. and W. C. Cobbin (Naval Radiological Defense Lab., San Francisco). Mar. 21, 1963. 79p.

The simulation of a realistic fallout environment was required for the design of experiments to evaluate post-nuclear attack reclamation equipment and procedures. A simplified mathematical fallout model was utilized to estimate fallout particle sizes, accumulated initial mass levels, and standard radiation intensities that might occur under specified conditions of weapon yield and downwind distance from a land surface nuclear detonation. Fallout particle size, deposited mass per unit area, and standard radiation intensity, as functions of downwind distance and weapon yields from 1 KT to 100 MT are presented graphically to facilitate rapid selection of simulated fallout environments. (auth)

**29139** (USNRDL-TR-645) GROUND ROUGHNESS EFFECTS FOR FALLOUT-CONTAMINATED TERRAIN: COMPARISON OF MEASUREMENTS AND CALCULATIONS. J. M. Ferguson (Naval Radiological Defense Lab., San Francisco). May 7, 1963. 29p.

The effect of ground roughness on the radiation field above fallout-contaminated ground is studied. At past weapons tests, the dose rate over fallout-contaminated ground has been measured as a function of height and angle. These measurements are compared with calculations of the same quantities for 1.12-hr fission products uniformly distributed on a smooth plane. None of the experiments is detailed enough to lead to firm conclusions about the ground roughness effect. However, the data indicate that the ground roughness effect can be simulated by assuming that the fallout is buried under a thin layer of material. For desert terrain this thickness of material is equivalent to about 25 ± 10 ft of air. At 3 ft above the ground this corresponds to a reduction in dose rate by a factor of 0.6 to 0.7, compared to what would be received over a smooth plane. (auth)

**29140** (AEC-tr-5810) PRELIMINARY GUIDE-LINES FOR TESTING FILTERS FOR AIR- AND GAS-BORNE PARTICLES. (Hauptverband der Gewerblichen Berufsgenossenschaften, e. V. Staubforschungsinstitut, Bonn). Translation of "Vorlaufige Richtlinien zur Prufung von Filtern zur Abscheidung von Schwebstoffen" [1961]. 28p.

Filters for gas-borne particles include particulate filters and particulate filters of special grade "s." The filters exhibit high filtration of aerosols of all particle sizes, particularly those less than 1 μm. The filter types used for filtering bacteria and viruses are also considered. The properties and operation of filters are described. Procedures and equipment for testing the filters are described in detail. Radioactive aerosols are used in some of the tests. Finally, a table of minimum separation grades of test aerosols is given for good particulate filters and "s" grade filters. (D.L.C.)

**29141** CONCENTRATION OF DEUTERIUM IN SNOW LAYERS IN THE ANTARCTIC. Claude Lorius (College de France, Paris). Ann. Geophys., 17: 378-87(Oct.-Dec. 1961). (In French)

During the Victoria Land Traverse (Antarctica) about 130 samples of snow and glacier ice were collected. Analysis on precipitations lead to a relation between tempera-

ture of formation and deuterium content. This relation was used as the base of typical features of the antarctic troposphere to distinguish the seasonal layers of glacier ice. The deuterium content of deposits was then related on the mean annual temperatures in different stations. Several possible applications of the findings are discussed. (C.H.)

**29142** PROCEEDINGS OF THE POISON CONTROL CENTER TECHNICAL ADVISORY COMMITTEE: RADIATION POISONING. Harold Jacobziner and Harry W. Raybin (Dept. of Health, New York). Arch. Pediat., 79: 130-6(Apr. 1962).

Radiation hazards are discussed from the point of view of sources of radiation, biologic effects, and symptoms of radiation sickness and its treatment. Cases of poisoning from ingestion of luminous paint are described. In the four cases studied, nothing was demonstrated in terms of internal deposition. This material apparently went through the intestine and only an insignificant fraction was absorbed. Various means for removal from the body of ingested radioisotopes are reviewed, and the possible hazards of exposure of children to $Sr^{90}$ and $I^{131}$, from fallout, present in milk, are discussed. (H.H.D.)

**29143** STRONTIUM-90 LEVELS IN THREE INFANT FORMULA FOODS. Anita A. Jarvis and John R. Brown (Univ. of Toronto). Can. Med. Assoc. J., 86: 73-5(Jan. 13, 1962).

Lower levels of $Sr^{90}$ were found in human and soybean milk than dairy products. Explanation of the phenomenon and implications relative to the design of infant diet are discussed. (H.M.G.)

**29144** EVOLUTION OF THE TRITIUM CONCENTRATION IN PRECIPITATION IN FRANCE. Roland Birron, Georgette Delbrias, and Jacques Labeyrie (CEN, Saclay, France). Compt. Rend., 256: 4951-4(June 5, 1963). (In French)

The evolution of the T concentration in precipitation in France was followed since November 1958. The evolution, identical to that observed in Sweden and Canada, shows the seasonal increase usually attributed to the injection of radioactive debris from the stratosphere into the troposphere. It also shows a variation identical to that of $Sr^{90}$ in precipitation and confirms the existence of a similar mechanism to explain the transport of tritium in the form of water vapor and the transport of fine particles of $Sr^{90}$. (tr-auth)

**29145** ULTRASONIC DECONTAMINATION OF SURFACES CONTAMINATED WITH IODINE-131. Jovan Gligorijevic, Bosko Pavlovic, and Desanka Novcic. Glasnik Hem. Drustva, Beograd., 27: 65-75(1962).

Five minutes of ultrasonic decontamination in water proved to be effective (nearly 90%) on nickel, zinc, and aluminum. It had considerable effect on polyvinyl chloride but the material cracked under the effect. It had a faster effect than one hour of water on rubber and plexiglass, but had such a low effect on lead, copper, and brass as not to be useful. The effect was found to be higher in detergent solution. The decontamination effect depends not on the shape of the object but on the type of surface and the kind of material. The effect on a polished and smooth surface is much better than on a rough surface. (TCO)

**29146** RADIOACTIVE DECONTAMINATING. Kenneth W. Newman (Turco Products, Inc., Wilmington, Calif.). J. Am. Assoc. Contamination Control, 11: 15-16; 19(Apr. 1963).

The processes and chemical substances used to remove radioactive contamination from various surfaces are discussed, and specific substances for decontaminating human skin, aluminum, and other metals are cited. (Public Health Eng. Abstr., 43: No. 6, June 1963)

**29147** IN VIVO SOLID STATE RADIODOSIMETRY. Michael P. Westfall. J. Urol., 87: 737-8(May 1962).

To provide more accurate dose measurements and to evaluate scatter at different voltages, a device developed for monitoring radiation during the construction of a nuclear powered submarine was used. The device is a solid state dosimeter, in contrast to the commonly used photographic emulsion, which is a colloidal gel dosimeter. It employs elemental silver, dispersed as individual atoms in a solid state matrix (glass), which undergoes fluorescence in ultraviolet light. The emitted light has a wavelength of 5465 Å. The intensity of fluorescence of such a system is directly proportional to the number of elemental silver atoms present. Hence, the fluorescence of the dosimeter is directly proportional to the amount of radiation absorbed. The method for calibration is given. The dosimeter was found to be accurate in a range of 20 to 20,000 r. Once exposed to radiation the ability to undergo fluorescence will not deteriorate unless the glass is heated to 400°C. The dosimeter records radiation cumulatively; after the charge is cleared by heating, the dosimeter can be used again. By use of the dosimeter in clinical studies it was shown that when the pre-aortic lymph nodes are irradiated at the level of the renal pedicles with the 1000 kv machine, ~15% of the administered radiation impinges upon the kidneys. (TCO)

**29148** NATURAL RADIOACTIVITY OF POTASSIUM IN SOME FOOD PRODUCTS OF ANIMAL ORIGIN. Marcin Szulc (Main School of Rural Economy, Warsaw). Med. Weterynar. (Poland), 19: 196-9(Apr. 1963).

The natural radioactivity (background) of potassium for several basic food products of animal origin was established by averaging determinations of K content made by flame colorimetric photometry. The findings, in percent per gram, were for cow's milk (per milliliter) 1.15, powdered milk 10.22, beef muscle tissue 2.71, beef liver 2.26, bones of beef vertebrae 1.00, and fresh water fishes 2.41. (OTS)

**29149** SOME PROBLEMS OF MEDICAL PHYSICS IN WORK WITH SOURCES OF NEUTRON RADIATION. F. Minárik, A. Stankovičová, and J. Manca. Pracovni Lekar., 15: 69-74(Mar. 1963). (In Czech)

In view of the increasing importance of neutron sources in several fields of technology, the fundamentals of neutron radiation are reviewed. Passage of a neutron beam through matter may result in elastic scattering, inelastic scattering, or neutron reactions. The reactions are greatly dependent on the neutron energy. At low energies, (n,γ) reactions take place; they may be schematically indicated by the equation ${}^{A}_{Z}X(n,\gamma){}^{A}_{Z}X$, where Z designates the atomic number. At higher energies (n,p) reactions take place, according to the scheme ${}^{A}_{Z}X(n,p){}^{A}_{Z}X$, while at still higher energy levels the reaction may be described by the equation ${}^{A+3}_{Z+2}X(n,\alpha){}^{A}_{Z}X$. Beyond 13.2 Mev the (n,2n) and above 20 Mev the (n,3n) reactions may occur. The following neutron sources are used most often in the industry and in research work: Ra–Be and Po–Be, with the (α,n) reaction and Rn-Be and $Sb^{124}$–Be with the (γ,n) reaction. The sources are used for activation analysis, neutron therapy, geological logging, measurement of the moisture content, etc. Work with these sources must be carefully supervised by health physicists and medical personnel. (TTT)

**29150** ZASHCHITA NASELENIYA OT SOVEREMENNYKH SREDSTV PORAZHENIYA. (Protection of Population from Contemporary Means of Defeat). [I. S. Varen-

nikov and L. V. Vinogradov]. Moscow, Volunteer Auxiliary Society of the Army, Air Force, and Navy, 1963. 256p.

Civil defense methods and equipment for use in nuclear attack are outlined. (C.E.S.)

**29151** STUDIES OF THE FATE OF CERTAIN RADIONUCLIDES IN ESTUARINE AND OTHER AQUATIC ENVIRONMENTS. Proceedings of a Symposium held in Savannah, Ga., to Study Various Aspects of Radiological Surveys of Aquatic Environments. Julius J. Sabo and Paul H. Bedrosian, eds. (Public Health Service, Washington, D. C.). May 1963. 73p. (Free)

In a symposium on the fate of radionuclides in the Savannah River Estuary and in two river systems, procedures are described which can usefully be applied to investigations of other aquatic systems. The studies involve surveillance and monitoring techniques and the development of equipment and methods. A discussion of the hydraulics of the Savannah Estuary describes the characteristics of river and tidal currents and distribution of salinity and sedimentation; these form a basis for effective sampling and interpretation of radiological data and their application to aquatic and ecological studies. Field and laboratory studies on the accumulation of nuclides by organisms are described and interrelated. It is shown that more useful information can be developed when specific nuclides, rather than gross activity, are investigated. Improvements in sampling methods, especially in silt collection, are described in detail. These studies emphasize the multidisciplinary aspects of radiological surveys of aquatic environments. (auth)

**29152** SELECTED BIBLIOGRAPHY OF RADIATION PROTECTION ORGANIZATIONS. (American Conference of Governmental Industrial Hygienists, Cincinnati). 1963. 111p. $2.00.

Information is summarized on national and international organizations whose activities relate to radiation protection. Examples are listed of typical reports issued by each organization. (C.H.)

**29153** TRANSPORTABLE CASE FOR RADIOACTIVE DECAY HEAT PRODUCING MATERIAL, e.g. FOR BURNED-UP FUEL ELEMENTS FROM NUCLEAR REACTORS. Hermann Kuester (to Siemens-Schuckertwerke). German Patent 1,146,209. Mar. 28, 1963. Filed Oct. 21, 1960.

The transportable case described consists of an outer shell and a preferably cylindrically shaped shielding within the shell and apart from it so that a ring-shaped space is formed between them through which a coolant medium is circulated by natural convection. The natural convection of the coolant medium is achieved by providing conduits at the top and at the bottom of the shielding which communicate the interior of the shielding case where the radioactive material is contained with the ring-shaped space. (Gmelin Inst.)

**29154** POWDERS FOR EXTINGUISHING FIRES. Lawrence H. Cope (to United Kingdom Atomic Energy Authority). U. S. Patent 3,095,372. June 25, 1963. Priority date July 6, 1959, Great Britain.

The development of a powder suitable for extinguishing fires of burning U, Pu, or Th is described. The powder consists of a mixture of powdered inorganic chlorides and/or fluorides inert towards the burning metal. The mixture has a melting point below the melting point of the burning metal such that fusion of the powder takes place locally where the powder contacts the burning metal. A frit is formed around the locally fused portion of the powder, excluding the ambient atmosphere from the metal. Absorption of latent heat by fusion of the locally fused portion of the powder exerts a chilling effect on the metal. Examples of preferred powder mixtures are given. The mixture can be prepared by grinding the components together, but preferably the components are fused together before grinding to facilitate melting upon application to a fire. After a fire has been extinguished, U or Pu may be recovered from the residues by leaching with water to remove the soluble chlorides. (P.C.H.)

# INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

*Refer also to abstracts 29166, 29853, 29855, and 29856.*

**29155** (HW-77375) SHIELDING REQUIREMENTS FOR PROMETHIUM SOURCES. H. H. Van Tuyl, F. P. Roberts, and E. J. Wheelwright (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1963. Contract AT(45-1)-1350. 37p.

A theoretical analysis of the shielding required for large amounts of promethium was made, including an analysis of the radiation contributions from $Pm^{146}$ and $Pm^{148}$ at different times after reactor discharge. The results are compared with experimental determinations on samples of promethium at different ages, and promethium is compared with other radionuclides which may be used in power sources. As a first approximation, shielding requirements for promethium aged less than 2 years from reactor discharge are comparable to those for $Sr^{90}$ or $Cs^{137}$. For promethium aged over 2 years, shielding requirements are comparable to those for $Pu^{238}$. Shielding an aged (over 2 years) promethium oxide source to 10 mr/hr at 1 meter would require about ¼ inch of uranium for a 100 watt source, and ⅔ inch for a 1000 watt source. For optimum geometries, these shield weights correspond to 3 and 4 times the source weight respectively. Shielding to a dose rate of 1 r/hr at 1 meter would require shielding of weight less than one tenth of the source weight. The former case would permit close approach of personnel, while the latter would afford ample protection for most auxiliary equipment. (auth)

**29156** (ORNL-TM-562) PRODUCTION OF $I^{125}$ AND FABRICATION OF $I^{125}$ X-RAY SOURCES. H. T. Russell (Oak Ridge National Lab., Tenn.). July 19, 1963. Contract [W-7405-eng-26]. 8p.

Two 2-curie sources of $I^{125}$ were prepared for use as portable x-ray sources. A procedure for direct recovery of carrier-free $I^{125}$ was also demonstrated. (auth)

**29157** (TID-18981) STUDY OF SEQUESTRATION OF METAL IONS IN BRINE USING RADIOISOTOPES. Robert N. Thompson and George W. Reid (Oklahoma. Univ., Norman. Research Inst.). Aug. 1, 1961. Contract AT (40-1)-2698. 23p. (OKLA-2698-1)

Successful water flooding for secondary oil recovery by the petroleum industry is largely dependent upon the quality of injection water. To utilize the industry's abundant supply of natural brines (thereby affording disposal of a major pollutant in oil producing areas), it is necessary to first condition them to minimize corrosion, prevent plugging of sand formations, and improve their overall efficiency. "Below ground treatment" is a method used to avoid the considerable expense of coagulation, sedimentation, filtration, aeration, chemical treatment, and deaeration. It consists of introducing a sequestrant (complex phosphates and citric and acetic-acid derivatives) into untreated brine prior to injection in order to complex specific metal ions (calcium, magnesium, iron, and barium in combination with carbonate, sulfate, sulfide, and hydroxide radicals). To evaluate the effectiveness of the sequestering agents without resorting to the time-consuming analytical chemistry methods, a radioisotope technique is investigated. A synthetic brine containing specific ion concentrations is tagged with $Ca^{45}$ (natural brines contain high concentrations of calcium) and treated with varying concentrations of sequestrant. After precipitating the unchelated calcium, a sample of the supernatant is withdrawn, evaporated to dryness and counted. The count is a measure of the degree of sequestration. Results are favorable. (auth)

**29158** (TID-19008) RADIOACTIVE TRACER TECHNIQUES FOR DETECTING AND MEASURING DETERGENT RESIDUE ON WASHED FOODS AND EVALUATION OF FOOD WASHING PRACTICES. Progress Report. Walter A. Mercer (National Canners Assn. Western Research Lab., Berkeley, Calif.). Nov. 1960. Contract AT(04-3)-296. 48p.

Commercial food washing procedures were evaluated to determine the effect of variations in washing conditions on the final cleanliness of the washed foods. Asparagus was selected as the test food. The extent of removal of bacterial spores measured the effectiveness of the washing conditions in removal of natural contaminants. Alkyl benzene sulfate, labeled with $S^{35}$, was used for detecting and measuring trace amounts of detergent in wash water and on washed asparagus by radiochemical techniques. (C.H.)

**29159** THE EFFECT OF NUCLEAR TECHNOLOGY ON THE OIL INDUSTRY. Atomwirtschaft, 8: 342-3(June 1963). (In German)

There is shown to be very little prospect that nuclear energy will, in the foreseeable future, displace natural oil products from their essential fields of application. All possible spheres of utilisation of nuclear energy are scarcely noticeable compared with the large annual growth in the use of oil. The effects of technical nuclear developments on oil technology, however, are of more significance. Numerous application possibilities for radioisotopes and their radiations in the search for crude oil, its recovery and processing, in the use and analysis of natural oil products and, not least, in the fields of oil research are described. Known applications, which already save the mineral oil industry considerable expense, include the surveying of natural gamma radiation fields in connection with the search for oil, the continuous measurement and control of the content level of containers, of density, and of composition and the following of mixing and transport processes in refining operations. Radiation chemistry represents a field additional to the very varied applications of radiochemical methods in mineral oil analysis and research. It is not only a question of developing lubricating materials for nuclear energy installations which can withstand high doses of ionising radiation but the development of new processes which could lead to new petroleum products. (auth)

**29160** TRACER AND RADIATION APPLICATIONS IN ANALYSIS AND RESEARCH PROBLEMS OF OIL TECHNOLOGY. L. Wiesner. Atomwirtschaft, 8: 343-6(June 1963). (In German)

In addition to the various techniques of chromatography and ion exchange they include in particular mass spectrometry, methods based on x-ray diffraction, absorption and fluorescence, and the use of radioisotopes and their radiations. In oil analysis sulfur and other heavier elements can

be easily assessed by absorption processes in a substance consisting mainly of light elements. $Fe^{55}$ and tritium serve as sources of radiation and to carry out an absorption analysis requires on the average only about five minutes. In a corresponding way the scattering of beta particles, which increases with atomic number, may be used to determine the lead content of petrol. Hydrogen shows an absorption cross section for beta particles and gamma quanta which is about double that of other light elements. This forms the basis of a technique for hydrogen determination. The three elements hydrogen, sulfur, and lead whose content in oil products is most often in question may thus be determined in a nondestructive way by this absorption process with the same apparatus in a single test. (auth)

**29161** PRACTICAL APPLICATIONS OF RADIOISOTOPES IN OIL REFINERIES. C. Vernimb. Atomwirtschaft, 8: 346-50(June 1963). (In German)

Use of radioisotopes in the oil industry is discussed. There are a series of radiation transmission processes which can be carried out at relatively small expense. A radiation measuring instrument and a radioactive source of small activity suffice as standard equipment for the routine monitoring of pipe-lines. Other applications of closed sources include the measurement of flow velocity, quantity measurement, as well as the determination of hydrogen and sulfur contents in analysis techniques. The use of open sources of radiating materials as indicators is extensive and permits the determination of much operational data which, in practice, could be obtained by no other method. In addition to such process investigations, which are usually undertaken only once, many routine techniques were introduced. (auth)

**29162** ASPECTS OF RADIATION-CHEMICAL REACTIONS IN OIL TECHNOLOGY AND PETROLEUM CHEMISTRY. O. Vetter (Institut für Erdölforschung, Hanover). Atomwirtschaft, 8: 350-2(June 1963). (In German)

The $Co^{60}$ and $Cs^{137}$ radiation sources are only to be considered for the irradiation of relatively small quantities of material or for reactions which require small doses. In spite of a continual decrease in price these sources could scarcely be considered by the raw materials industry on grounds of cost. Future prospects are shown to lie with the so-called chemistry nuclear reactor which will be built mainly for the irradiation of materials. The cracking of oils is one important task to be solved by technical radiation chemistry. A further important application may be in the desulfurisation of petroleum compounds. Radiation isomerisation also possesses great technical interest. An early introduction of the new methods is to be expected in the fields of halogenization, nitration, sulfo-chlorination, etc. In addition to the radiochemical synthesis of compounds the large irradiation installations have great significance in the field of radioinduced polymerisation. (auth)

**29163** USE OF RADIOISOTOPES IN POLAROGRAPHY. NOTE I. INVESTIGATION OF THE BEHAVIOR OF Fe(III). Loris Busulini and Flavio Spalletti (Università, Padua; CNR, Padua; and CNEN, Padua). Ric. Sci., Rend. (2), 3: 100-6(Jan. 1963). (In Italian)

A preliminary attempt was made to study the possibility of using radioisotopes in polarography with the object of investigating electrode reactions. This was possible by substituting for the current/voltage curves the corresponding radioactivity/voltage curves, after suitable modification of the method. The system considered was a solution of $Fe^{3+}$, which was studied under different experimental conditions. The polarographic and the radiochemical data were in good agreement. (auth)

**29164** PRINCIPI I METODE PRIMENE RADIOAKTIVNIH IZOTOPA U INDUSTRIJI. (Principals and Methods of Using Radioactive Isotopes in Industry). Aleksander B. Milojević, Vladeta V. Uroševič, and Milan V. Kurepa. Belgrade, Yugoslavia, Naučna Knjiga, 1963. 297p.

An attempt was made to encompass monographically the utilization of radioisotopes on the basis of the published literature, especially of papers since the First Geneva Conference in 1955. The physical foundations and the theory are presented without assuming special knowledge of the nuclear field on the part of the reader. The appendix contains tabular material needed for solving practical problems. The subjects treated include the following: structure of matter, radioactive decay, interaction of radiation with matter, detection and measurement of the radiation, instrumentation, preparation of radioisotopes in the reactor and in the cyclotron, use of labeled compounds, application in analytical chemistry, activation analysis, study of reaction mechanisms, metallurgical processes, wear resistance measurements, corrosion studies, applications in the oil industry, liquid level indicators, radiography, gammagraphy, flaw detection, ionization of gases, radioluminescence, effect on radiation on plastics, synthetic methods, conservation of foodstuffs, the concept of maximum permissible dose, radiotoxicity, design of radiochemical laboratories and of apparatus, and decontamination and disposal of radioactive waste materials. (TTT)

**29165** SENSITIZERS FOR THE RADIATION-INDUCED VULCANIZATION OF NATURAL RUBBER AND OTHER HYDROCARBON POLYMERS. S. M. Miller, M. W. Spindler, and R. L. Vale (Wantage Research Lab., Harwell, Berks, Eng.). IAEA Preprint CN-14/27. 19p. (In English)

To be published in Proceedings of the IAEA Conference on the Application of Large Radiation Sources in Industry, Salzburg, Austria, May 1963).

A laboratory study of sensitizers that enable the dose for a satisfactory cure to be reduced from 40-50 megarads to 3-5 megarads, or even lower doses if conditions are carefully controlled, is described. The mechanism of the reaction is described and it is shown that as the radioinduced cross-linking reaction in the presence of the sensitizers is a chain process, the reaction becomes dose rate dependent and, therefore, it is favored by the use of isotope sources giving a low dose rate. The physical properties of the cross-linked rubbers are compared with those made by peroxide and sulfur-curing techniques and the differences are explained in terms of the nature of the new type of crosslink. Isotopically-labeled sensitizers were used to determine independently the concentration of crosslinks produced by radiation initiation. (P.C.H.)

**29166** PRIMENENIE RADIOAKTIVNYKH IZOTOPOV DLYA KONTROLYA KHIMICHESKIKH PROTSESSOV. (Application of Radioactive Isotopes in Control of Chemical Processes). R. V. Dzhagatspanyan, R. F. Romm, and L. K. Tatochenko. Moscow, State Publishing House of Chemical Science and Technology, 1963. 344p.

Basic theory and apparatus for the application of radioisotopes in the control and regulation of chemical processes are presented. Apparatus for the control of density and concentration in chemical reactions and crystal growing processes are described. Methods for the concentration analysis of gases and liquids are outlined. The design and

operation of various radiation detection instruments are included. Shielding and other safety precautions for handling radioisotopes are also discussed. (C.E.S.)

**29167** IMPROVEMENTS IN OR RELATING TO PACKAGE IRRADIATION SYSTEMS. Sidney Jefferson and Frank Rogers (to United Kingdom Atomic Energy Authority). British Patent 927,364. May 29, 1963. Filed Jan. 20, 1960.

An apparatus is patented, which conveys packages past a sheet-like source of radiation, gives each package a substantially uniform dose, and utilizes most of the $4\pi$ solid angle of radiation from the source. The packages are suspended from an overhead monorail system and conveyed past radiation sources in such a way that both sides of the package receive essentially the same exposure. The packages are then reversed with respect to their vertical positions and re-exposed. The design of the apparatus is described in detail. (M.P.G.)

**29168** PROCESS FOR IRRADIATING HIGH HYDROCARBON COATINGS ON METAL TO FORM POLYMERIC COATINGS AND RESULTANT ARTICLE. Alexander Thomas Wilson (to Standard Oil Co.). U. S. Patent 3,090,698. May 21, 1963. Filed Feb. 14, 1961.

A process for producing polymerized chemical coatings on metals is patented. A nonvolatile, low-melting-point organic substance, such as a heavy oil, wax, fatty acid, or asphalt is extended in the form of a film on the surface of an oxidizable metal. The film is exposed to ionizing radiation in the energy range of ~1 to 500 kv from a low-voltage electron accelerator. The intensity of radiation should be at least 10 kwh/lb of product. This converts the film to a hard, relatively infusible plastic film tenaciously bound to the metal surface. Details of the process and specific examples are presented. (M.P.G.)

**29169** RADIOACTIVE TEMPERATURE INDICATING DEVICES. Sigmund Berk (to U. S. Army). U. S. Patent 3,090,862. May 21, 1963. Filed Aug. 31, 1959.

A device for indicating whether a container-enclosed component has been previously subjected to critical temperatures is patented. A radioactive source is located in the vicinity of the enclosed component, and a detector and indicator are outside the enclosure. The source is shielded by a material, which melts when the temperature within the enclosure has had a predetermined value for a predetermined time. Another method consists of having the source exposed until a certain temperature is reached, when the shield support melts, dropping the shield around the source. Other variations are described, including a method for measuring the highest temperature reached within the enclosure. (M.P.G.)

# INSTRUMENTS AND INSTRUMENTATION

## General and Miscellaneous

*Refer also to abstracts 29166, 29248, 29315, 29476, and 29712.*

**29170** (ASD-TDR-63-233) RESEARCH AND EVALUATION OF MATERIALS FOR THERMOCOUPLE APPLICATION SUITABLE FOR TEMPERATURE MEASUREMENTS UP TO 4500°F ON THE SURFACE OF GLIDE RE-ENTRY VEHICLES. W. C. Kuhlman (General Electric Co. Advanced Technology Services, Cincinnati). May 1963. Contract AF33(657)-8472. 75p.

The thermoelectric output versus temperature of a W/W-26Re thermocouple was measured to 5800°F. Thermoelectric sensitivity was relatively high over the entire temperature range. Thermoelectric output on new thermocouple systems versus temperature was also measured with respect to W–26Re commercial wire for Re, Re–W, Re–Ru, Re–Rh, Re–Pt, Re–Ir, Re–Mo, Re–Os, Mo, Mo–W, Mo–Re, and Ir–Re alloy materials. Of the alloys studied, Re–10Ru and Re–12W showed the greatest potential for high-temperature thermocouple application. The oxides BeO, $ThO_2$, and $HfO_2$ are compared as electrical insulators. Beryllia is best, but with proper geometry $ThO_2$ and $HfO_2$ would also be satisfactory. Boron nitride was found to react with W and W–26Re materials above 3700°F in He. The melting points of many rare earth oxides, zirconates, and hafnates were determined. Weight losses of Ir, Ir–10Re, Os, Ir–50Os, and Ir–20Os at 0.1 atmosphere pressure at approximately 4400°F were measured. The test shows that Ir–20Os alloy, with a measured melting point of 4600°F, should make satisfactory sheathing material for short time service. (auth)

**29171** (NP-12947) A RADIOFREQUENCY MASS SPECTROMETER. K. Ryan (New South Wales, Australia. Univ., Kensington). [nd]. 27p.

Some aspects of the present status of radiation chemistry are briefly mentioned. In particular, the application of mass spectrometry to the solution of problems concerned with the radiation of gases is discussed. The similarity between processes occurring in the ion-source of the mass spectrometer and those occurring when gases are subjected to high energy radiation is noted. It is pointed out that the nature of the products formed depends to a greater extent on the pressure employed than on the type of radiation used. The Bennett type r-f mass spectrometer should be a suitable instrument for the study of mass spectra of simple hydrocarbons. The theoretical basis for such an r-f mass spectrometer is given, and the constructional procedure for the instrument reported here is outlined. Performance of the instrument is discussed, and some of the departures from conventional operating modes are mentioned. The instrument is showing promise in its ability to produce quantitative results. Some of the difficulties involved in the conversion of this instrument to a quantitative mass spectrometer are discussed. (auth)

**29172** (ORNL-TM-606) ANALYTICAL DETAILS CONCERNING "MACHINE TIME" IN TIME-AMPLITUDE CONVERSION. W. F. Mruk (Oak Ridge National Lab., Tenn.). June 20, 1963. Contract W-7405-eng-26. 11p.

The analytical details are developed for establishing "machine time" in time-amplitude conversion systems using photomultipliers whose output pulses are treated in two specific ways for obtaining timing information. (auth)

**29173** (RIB-45) DEVELOPMENT OF HIGH SPEED ELECTRON ACCELERATOR STRUCTURES. Interim Report No. 12, August 1, 1956–November 1, 1960. (David Sarnoff Research Center, Princeton, N. J.). Contract AT(30-1)-1958. 47p.

A central electrode photomultiplier with a response time $^1/_{10}$ that of the best present photomultiplier and with a potential time resolution below 0.1 nanosec was completed and tested. Since the high speed photomultiplier has too low a rise time to act as the limiting element in a timing system, the best possibility for improving timing accuracy seems to lie in increasing the magnitude of the photomultiplier output signal. Methods for using a travelling-wave system to extract more efficiently the energy contained in the output beam pulse were examined, and preliminary experimental studies (inconclusive) were made. A vacuum (beam deflection coincidence) tube designed specifically for determining the coincidence of two pulses with high accuracy was built and tested. Using typical multiplier output pulses, the resolution of the tube was just over 0.1 nanosec; using mercury switch pulses, it was under $5 \times 10^{-12}$ sec. The cause, nature, and possible remedial measures for dark current in photomultipliers were investigated. A reasonable hypothesis was formulated for its fundamental causes, and suggestions were made for designing and processing the tubes to reduce the dark current. An expression was derived for the amount by which the photomultiplier degrades the inherent pulse height resolution of a scintillation crystal. (D.C.W.)

**29174** (TID-18960) AN AUTOMATED SYSTEM FOR THE MEASUREMENT OF INTERNAL FRICTION. Randall K. Cole, Jr. (Cornell Univ., Ithaca, N. Y.). June 1963. Contract AT(30-1)-2471. 28p.

The Quimby composite oscillator as modified by Marx together with a feedback amplifier system patterned after the internal friction spectrometer of Thompson and Glass provides a simple, accurate method of continuously and automatically monitoring internal friction measurements, with all the advantages of a steady-state technique. The design, construction, and principles of operation of such a system working at 80kc are described, and the stability and limitations are analyzed. (auth)

**29175** (UCRL-10418) AN EFFICIENT ELECTROMECHANICAL COUNTER CIRCUIT. Ronald Zane (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 14, 1962. Contract W-7405-eng-48. 4p.

A simple circuit is designed for driving an electromechanical counter from the overflow output of a scaler in a nuclear counting instrument. The circuit is to operate on the output pulse from a saturating flip-flop, but it could be driven from any low-power pulse source. (D.L.C.)

**29176** (UCRL-10754) A PULSE MODULATOR THAT CAN BE USED AS AN AMPLIFIER, A MULTIPLIER, OR A DIVIDER (thesis). Jerome A. Rosenthal (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 2, 1963. Contract W-7405-eng-48. 53p.

A pulse modulator that offers several useful features is introduced. Some of its desirable features are that it can respond without delay to a change in input signal and that it is of very simple construction. The modulator can be

used as an amplifier, a multiplier, or a divider. It can also be used to control either proportional or on-off systems. (auth)

**29177** (NP-tr-1031) HIGH VOLTAGE TESTING EQUIPMENT AND MEASUREMENTS. A. A. Vorob'ev (Vorobyev), G. A. Vorob'ev (Vorobyev), et al. Translation of "Vysokovol'tnoye Ispytatel'noye Oborudovaniye i Izmereniya" (a publication of Gosenergoizdat, Moscow, 1960). 719p. (MCL-1265/1+2).

Testing equipment and methods for measuring high and superhigh voltages are described. Information is included on laboratory designs, voltage regulators, pulse and high-voltage transformers, electrostatic and cascade generators, rectifiers, pulse generators, voltameters, electric discharge, spark gap, electron tubes, pulses, oscillographs, circuits, and nuclear generators. (N.W.R.)

**29178** A HYPERFREQUENCY SPECTROGRAPH FOR THE STUDY OF IRRADIATED SUBSTANCES. Robert Adde and Pierre Petit (Institut d'Électronique, Orsay, France). Compt. Rend., 256: 4625-7(May 27, 1963). (In French)

A description is given of a device in which the sample can be simultaneously irradiated and exposed to electron paramagnetic resonance study. The irradiation is made with an electron accelerator, and the electron resonance is detected with a spectrograph operating in the 3-cm band. (tr-auth)

**29179** INTERFERENTIAL MEASUREMENT OF THE THICKNESS OF ANODIC DEPOSITS OF ALUMINUM OXIDE. G. Cannet. Corrosion Anti-Corrosion, 11: 176-9(May 1963). (In French)

The measurement of the thickness of thin anodic oxide deposits (of the order of 10 microns) on Al by the interferential optical method was studied. The classical methods used for this measurement (chemical dissolution, measurement on microscopic cuts, and electric breakdown) are reviewed briefly. The principle and mode of realization of the optical interferential method, with a Hardy recording spectrophotometer, operating in the visible spectrum, are described. The results obtained show a satisfactory agreement with those obtained by procedures of dissolution and micrography. (tr-auth)

**29180** THEORETICAL STUDY AND REALIZATION OF A MOCK-UP OF A $\beta$ SPECTROGRAPH WITH GREAT LUMINOSITY. G. Lucenet, J. Riche, and J. Lafoucrière. J. Phys., 24: 78-9(Jan. 1963). (In French)

A theoretical study was made of the trajectories and receivers of a $\beta$ spectrograph having trochoidal trajectories in an inhomogeneous magnetic field of revolution with constant rH. Trajectories were constructed for $u_0$ from −180 to +180° at 15° intervals and $\theta_0$ from 0 to 24° at 3° intervals. The luminosity and power of resolution were calculated for each case and for various lengths of the detector slit and diaphragm slit. Some of the values obtained are tabulated. A mock-up of the proposed spectrograph was made to study the topography of the $r^{-1}$ magnetic field. The polar pieces are trunks of a cone of revolution in mild steel connected by a core 96 mm in diameter. (J.S.R.)

**29181** PHOSPHOROSCOPE DESIGNED FOR THE STUDY OF LUMINESCENT DECAYS AT DIFFERENT TEMPERATURES. Joseph Janin and Robert Dunand (Universite, Lyon). J. Phys., 24: 81-3(Jan. 1963). (In French)

In order to study luminescent decay in a large temperature interval (from −190 to 400°C), a photoelectric phosphoroscope was constructed with an exciting radiation source arranged on an optical layer, a removable metallic Dewar flask, a photomultiplier, and a modulator for the PM electron beam. Schematic diagrams of the apparatus are given. The conditions for blocking the emission of the 56 AVP tube (a photomultiplier tube provided with triode input electron optics) were analyzed and the blocking circuit was determined. The electronic circuit of the apparatus is given. (J.S.R.)

**29182** A HONEYCOMB COLLIMATOR OF VARIABLE FOCUS FOR USE IN RADIOISOTOPE SCANNING. Alipio L. Dias Neto (Universidade, Sao Paulo, Brazil). Nucl. Med., 3: 221-5(1963). (In English)

A multi-channel collimator with variable focus for general use in medical radioisotope scanning is described. (auth)

**29183** CELL FOR USE IN RADIATION ABSORPTION ANALYSIS. Edward O. Haenni (to Dept. of Health, Education and Welfare). U. S. Patent 3,090,861. May 21, 1963. Filed Jan. 28, 1960.

A sample-holding absorption cell of greatly simplified construction for use in infrared radiation absorption analysis is patented. The cell consists of an internal fluid-tight chamber for holding the sample, with front and back windows separated by a spacer. Communication with the sample chamber is effected solely through ports in the spacer and hypodermic needles connected to the ports. The design of the cell and the advantages of the design are described in detail. (M.P.G.)

**29184** VARIABLE CAPACITANCE TRANSDUCER WITH A RADIOACTIVE BATTERY. Joseph W. Crownover (to Gulton Industries, Inc.). U. S. Patent 3,095,476. June 25, 1963. Filed Jan. 8, 1954.

A compact, self-powered mechanoelectric transducer that can be combined with a phonograph pickup device or a microphone unit is described. The transducer uses a variable capacitance circuit with a radioactive d-c high-voltage source to impart an electric charge to the capacitive element. The voltage balance of the circuit is altered in accordance with movements of a vibration sensitive element to produce voltage output fluctuations that correspond in frequency and amplitude to those of the source of mechanical or acoustical vibrations. (C.E.S.)

**29185** RESERVOIR CONTAINER MATERIAL FOR HYDROGEN FILLED DEVICES. John E. Creedon, Sol Schneider, and Norman L. Yeamans (to U. S. Army). U. S. Patent 3,095,518. June 25, 1963. Filed Jan. 4, 1961.

Equipment and a process are described for providing a long life container for a rare earth reservoir of a thyratron or other hydrogen filled device. Such a container for a thyratron permits operation at a pressure of 300 to 800 $\mu$ and at a temperature about 700°C for a period in excess of 1000 hr. It was found that certain objectives can be attained and certain container difficulties overcome by enclosing the rare earth reservoir in a rare earth oxide coating. (P.C.H.)

**29186** ION GENERATING AND FOCUSING MECHANISM. Charles E. Burdg (to Combustion Engineering Inc.). U. S. Patent 3,096,435. July 2, 1963. Filed Dec. 9, 1960.

Tons provided by an electrically heated ribbon supported in a trough in a block are focused by a slit in a plate aligned with the trough. The block is supported in a housing that is in turn, held and positioned in a support on the mass spectrometer by a vacuum and by the shape of the housing that is machined to fit a receptacle in the support. Sealing between the housing and support is provided. Samples can readily be changed, and the device is easily assembled. (D.C.W.)

**29187** ION LENS SYSTEM. Charles E. Burdg (to Combustion Engineering Inc.). U. S. Patent 3,096,436. July 2, 1963. Filed Dec. 9, 1960.

A removable lens system for a mass spectrometer comprises two accelerating and focusing plates and two collimating plates incorporated into a unit that can readily be removed for cleaning or replacement. Provisions are also included for accurately positioning the system on the spectrometer and for shielding the beam from electric and magnetic fields from the plate wiring. (D.C.W.)

**29188** MEANS FOR PULSING AN ION BEAM. Julius J. Muray (to High Voltage Engineering Corp.). U. S. Patent 3,096,437. July 2, 1963. Filed Mar. 27, 1961.

A system for pulsing a beam of ionized particles consists of a collector with a narrow slit axially aligned with an ion source. Between the collector and source are placed deflecting plates applying a bias voltage that moves the beam to one side of the slit and a sweep beam that moves the beam across the slit. Pulses are transmitted during part of the fast-use-time leading edge of a rectangular (really trapezoidal) sweep deflection pulse. Very short pulses can be produced over a range of frequencies. (D.C.W.)

## Radiation Detection

*Refer also to abstracts 28626 and 29133.*

**29189** (AERE-R-4122) SILICON SURFACE-BARRIER RADIATION DETECTORS; SOME DESIGNS AND APPLICATIONS. P. G. Salmon and F. L. Allsworth (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1963. 33p.

A wide range of semiconductor surface-barrier radiation detectors now being developed is described. The performance and electronic requirements of the detectors are discussed together with a general description of the techniques used in the preparation of the crystals and their subsequent encapsulation. The areas of the detectors range from a few $mm^2$ to a multiple detector with a total sensitive area of 14 $cm^2$. These detectors have wide applications in nuclear physics experiments and for radioactivity search and assay purposes, e.g., in health physics operations, and an outline is given of their practical advantages and limitations. The use of surface-barrier diodes for beta-particle detection is discussed together with details of detectors being developed for medical research purposes. (auth)

**29190** (AFSWC-TDR-63-28) INVESTIGATION, CONCEPTUAL DESIGN AND OPERATIONAL USE OF A DIRECTIONAL NUCLEAR RADIATION DETECTOR. Final Report. (Franklin Systems, Inc., West Palm Beach, Fla.). Apr. 1963. Contract AF29(601)-5405. 74p.

Several ground-based systems were shown to be feasible for defining the location, curie strength, and energy level of numerous and powerful radioactive gamma-emitting sources scattered across an area of 1,000-ft radius. These systems involve use of fixed survey sites, mobile sites, or a combination thereof. The preferred system would use two fixed and one mobile sites. Primary study considerations have involved accuracy of source location, radiation hazards to crew personnel, optimum means of source collimation, flexibility to adapt to various problem situations, and adaptability to use of certain 2nd–3rd generation aids involving airborne facilities and super-imposed visual displays. Radioactive background, detector shielding, and some equipment design factors are discussed. Opportunities and advantages for closely relating survey and decontamination operations are explained, and such a composite endeavor is recommended. (auth)

**29191** (AWRE-O-29/63) SENSITIVITY OF $\beta$ COUNTERS TO THE $\gamma$ AND CONVERSION SPECTRA OF CERTAIN $\alpha$ EMITTERS. L. P. O'Connor and R. S. Large (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). June 1963. 16p.

The $\alpha$ emitters $Am^{243}$, $Np^{237}$, and $Pa^{231}$ are commonly used as tracers or for calibration purposes in $\beta$ counting. High proportions of their disintegrations lead to excited states of the daughter nuclei which are deactivated by $\gamma$ emission associated with conversion electrons and x rays. As all of these will be detected by $\beta$ counters, the appropriate corrections have to be determined. Pure fractions of the $\alpha$ emitters from which the radioactive daughters were separated by chemical methods were counted in Geiger-Mueller and $\beta$ proportional counters. The purity of the sources was checked by observing the growth of the daughters with a $\gamma$ spectrometer. Absorption curves were also plotted. From the results, counter sensitivities at optimum absorber thicknesses were determined for the three nuclides. The results for $Am^{243}$ were corrected for the known growth of $Np^{239}$ during the time interval between chemical separation and counting. Results, expressed as counts per 100 $\alpha$ disintegrations, were obtained with a source-to-counter geometry of approximately 0.36 and at a total absorber thickness of 10 $mg/cm^2$. The counts obtained appeared to be due largely to low-energy x rays in the conversion spectra or to low-energy $\gamma$ radiations when present. The differences in sensitivity between proportional and Geiger-Mueller counters are attributed to different gas fillings. Experimental results for $Am^{241}$ and $Pu^{239}$ were also included for comparative purposes. (auth)

**29192** (BNL-7048) AN ELECTRONIC DIGITIZING SYSTEM FOR OPTICAL SPARK CHAMBER DATA. E. J. Rogers (Brookhaven National Lab., Upton, N. Y.). May 23, 1963. Contract [AT(30-2)-Gen-16]. 23p.

Capabilities of a scanning system using a vidicon TV camera tube are examined, and the design and operation of a proposed system are considered. The vidicon is noted to have sensitivity comparable to that of fast film and to be able to store optical information long enough for electronic digitization. (D.C.W.)

**29193** (CEA-2265) DETECTEUR PORTIQUE $\beta\gamma$. ($\beta$-$\gamma$ Porch Detector). R. Roulet (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Grenoble). 1963. 15p.

A monitor is described that is placed outside of reactors, hot laboratories, and other places where radioactive products are treated; it gives an alarm when someone passing through the porch is greatly contaminated or carries a radioactive substance. An adjusting system of sensitivity allows a 15 $\mu$C in $\gamma$ and 10 $\mu$C in $\beta$ radioactive source to be measured when passing through the porch at the normal walking speed. A battery, set in buffer, allows working of the device, even when current is off. (auth)

**29194** (CEA-2271) APPAREILLAGE POUR LA MESURE DES REPARTITIONS DE FLUX NEUTRONIQUES (DEROULEURS A BANDES ET A FILS). (Apparatus for the Measurement of the Distribution of Neutron Flux (Band and Wire Continuous Recorders)). H. Derrien and X. Y. Lemerle (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 24p.

The operation and principles of apparatus for determining the thermal neutron flux distribution in a pile channel

or along a fuel element are described. The β-activities of continuous detectors in the form of bands and wires are measured. Point by point or continuous analyses of the continuous detectors can be made. The presence of a very localized sudden discontinuity in the distribution curve can also be shown. (auth)

**29195** (CEA-2272) SPECTROMETRIE α PAR DETECTEURS JONCTION A BARRIERE DE SURFACE. (Alpha Spectrometry Using Surface Barrier Detectors). M. Sandon, C. Rabour, J. P. Longequeue, N. Longequeue, and H. Beaumevieille (France. Commissariat à l'Énergie Atomique. Centre d'Études à l'Énergie Atomique, Centre d'Études Nucléaires, Grenoble). 1963. 6p.

Junction detectors for α-spectrometry were short-lived, and surface barrier detectors were constructed from 50-Ω silicium. Results obtained with these detectors for α and $He^3$ particles in the range 2 to 9 Mev are given. The detectors have a negligible dead layer, and the energy resolution is 25 kev with 5.3-Mev α-particles. (auth)

**29196** (DP-821) AN AUTOMATIC SAMPLE CHANGER. Louis H. Cook, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). May 1963. Contract AT(07-2)-1. 19p.

An automatic changer with a 150-sample capacity was developed to facilitate counting of foils irradiated during reactor experiments. The samples are transported in special planchets through two scintillation counters by a rotating table. A standard sample is counted after every five samples. Time error accumulation is minimized by a fixed-cycle timer. A printer records the sample number and the total count. (auth)

**29197** (EUR-133.i) STUDIO DI UN DETETTORE DI NEUTRONI TERMICI PER DETERMINARE LA DISTRIBUZIONE DEL FLUSSO IN UN FASCIO COLLIMATO. (Study of a Thermal Neutron Detector to Determine Flux Distribution in a Collimated Beam). G. Fraysse and A. Prosdocimi (European Atomic Energy Community. Central Nuclear Measurements Bureau, Geel, Belgium). 1962. 21p.

Boron and lithium loaded scintillators for thermal neutrons were investigated. Their behaviors were determined throughout the study of pulse shape, light efficiency, and thermal neutron and gamma sensitivity. Owing to its satisfactory neutron efficiency and resolution, the lithium scintillator was adopted to equip a probe. An application was made in tracing the neutron flux space distribution of a beam coming out of a reactor. (auth)

**29198** (HW-77517) HIGH LEVEL DOSEMETER WITH METER INDICATION AND AURAL SIGNALING. C. A. Ratcliffe and E. M. Sheen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1, 1963. Contract AT(45-1)-1350. 10p.

A prototype dosemeter was developed and satisfactorily tested. It has a presettable trip dose from 10 to 100 r, an aural indicator that signals the accumulation of the preset dose, and a meter that indicates the dose accumulation. The dosemeter employs a 10-cc ion chamber as a detector and is both lightweight and pocket-sized. Operational periods of 30 minutes can be achieved before adjustment becomes necessary. (auth)

**29199** (JÜL-102-ST) EIGENSCHAFTEN UND BESTRAHLUNGSVERHALTEN SELBSTABLESBARER STABDOSIMETER. (Properties and Radiation Behavior of Self-Reading Rod Dosimeter). K. Becker and D. Nachtigall (Kernforschungsanlage, Jülich, Germany). Apr. 1963. 14p.

By comparison of rod dosimeters of different manufacturers with regard to their charge behavior and self-discharge, sensitivity to shock, exactness and fluctuations of dose registering, and energy and direction dependence, the Bendix dosimeter proved to be the best of the investigated types for registering quanta radiation. This dosimeter was therefore investigated more closely. The marked energy dependence of other dosimeters was reduced by suitable metal tops. Arrangements for measurement of fast neutrons by the Bendix dosimeter did not show the exactness of quanta doses. No satisfactory dose proportionality was found for them. The dosimeter readings were influenced an expected amount by the structure of the container. (tr-auth)

**29200** (LNF-63/33) ACCURATEZZA DELLA MISURA DI UNA TRACCIA IN CAMERA A SCINTILLA. Note No. 198. (Accuracy of Track Measurement in Spark Chamber). G. Corini and R. S. Jones (Italy. Comitato Nazionale per le Ricerche Nucleari. Frascati Laboratori). May 10, 1963. 7p.

In order to study the possibility of reconstructing from photographs the track of a particle in a spark chamber and to determine the precision limits of such a reconstruction, the following method was used. A straight line was drawn passing through the center of the first and last spark line. The distance between every other spark and the center of the straight line is then measured. This distance, shown graphically, leads to a construction of a distribution curve. The experimental apparatus is described. Both pure He and 10% He saturated with $C_6H_5OH$ were used as filling gases. 10 and 45 cm of Pb were used as absorbers. High amplification projection was used so that the distance could be measured with an error of the order of 0.3 mm. The data obtained are shown graphically and are discussed. It is concluded that in the case of high energy particles the reconstruction of the spark track is possible with a precision of less than one mm. (J.S.R.)

**29201** (NBS-TN-163) THE CONSTRUCTION OF CALORIMETERS FOR THE MEASUREMENT OF ABSORBED DOSE. Ben Petree and George Ward (National Bureau of Standards, Washington, D. C.). Nov. 1962. 36p.

Direct measurements of energy locally absorbed in irradiated materials can be made with adiabatic calorimeters of suitable design. Design criteria imposed by requirements of accuracy include limitations on size and complexity. Small calorimeters of simple design with precision better than 1% at dose rates above 1 rad/sec were developed. Details of fabrication, auxiliary equipment, and performance are described. (auth)

**29202** (NIRL/R/31) THE MEASUREMENT OF ACCELERATOR PRODUCED NEUTRON FLUX USING THE $S^{32}(n,p)P^{32}$ REACTION. K. B. Shaw (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). Mar. 1963. 13p.

The use of the reaction $S^{32}(n,p)P^{32}$ to measure the neutron flux resulting from proton bombardment of thick and thin targets in accelerators is discussed. Neutron angular distributions for 30-Mev protons on Al and Be are included. (auth)

**29203** (UCRL-6886) A METHOD FOR SUPPRESSING PHOTOMULTIPLIER NOISE. R. W. Hill and J. P. Stoering (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 15, 1962. Contract W-7405-eng-48. 9p.

The noise suppressor system described is designed to take advantage of the difference in pulse length of slow decay time scintillators such as CsI(Tl) and NaI(Tl) and the photomultiplier noise. This technique is similar to the

pulse shape discrimination system used to distinguish particle types detected by fast scintillators. The scheme used has the advantage of simplicity and of employing mostly standard electronic components. (N.W.R.)

**29204** (UCRL-10256) INSTRUMENTATION OF A HIGH-ENERGY CYCLOTRON EXPERIMENT. Melvin Brown (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 11, 1962. Contract W-7405-eng-48. 22p.

The instrumentation for processing data from an $(\alpha,2\alpha)$ experiment is described. System requirements are set forth and the instruments for fulfilling them are discussed. Special attention is directed to fast linear gates, the stretching of narrow pulses, and a basic transistor amplifier used in the system. Additionally, gain stabilization from the photocathodes of photomultipliers to the input of a four-dimensional analyzer is discussed. (auth)

**29205** A VERSATILE, DISPOSABLE DOSIMETER FOR SLOW AND FAST NEUTRONS. R. M. Walker, P. B. Price, and R. L. Fleischer (General Electric Research Lab., Schenectady, N. Y.). Appl. Phys. Letters, 3: 28-9(July 15, 1963).

Crystals such as mica and quartz, glasses, and plastics that exhibit radiation-damage trails from fission fragments when selectively etched were used as dosimeters for fast and thermal neutrons. The dosimeter consists of a thin detector sheet of such a solid covered by a sheet of fissile material. Recoiling fragments from neutron-induced fission produce tracks in the detector sheet, which is then etched and examined either microscopically or by a readout device to obtain the number of etched-out holes. For monitoring very high doses, the fissile cover is omitted and uranium impurities in the solid itself are utilized. Most of these solids are completely insensitive to gamma rays, electrons, protons, and alpha particles. (C.E.S.)

**29206** NUCLEAR INSTRUMENTATION. NO. 16. Bull. Inform. Sci. Tech. (Paris), No. 70, Suppl., 1-47 (Mar. 1963). (In French)

The majority of nuclear physics studies has the purpose of determining simultaneously the different physical magnitudes characterizing a phenomenon. A multidimensional analysis chain was developed for this purpose. The analysis chain is composed of functional units, each assuring a given function and connected by a purely parallel binary code. The input units and memory blocks of such an analysis chain are described. The characteristics of the devices handling the output of the analysis chain are given. The design and characteristics of new instruments (windowless photomultiplier, automatic radiation detection instrument for sources of different forms, atmospheric monitor for the fluorine ion, multiple probe detector, atmospheric monitor for iodine, atmospheric monitor for tritium, portable fluorimeter, scanning device for bubble chamber photographs, and oscillographs) are described. (J.S.R.)

**29207** A SIMPLE FAST-SLOW COINCIDENCE SYSTEM FOR ANGULAR CORRELATION MEASUREMENTS. Frane Marčelja (Institut "Ruder Boskovic," Zagreb). Glasnik Mat.-Fiz. Astron., Ser. II, 17: 113-15(1962). (In English)

A system for measurement of the $(N,N'\gamma)$ angular correlation consisting of a fast and a slow part was developed. The "yes" of the fast coincidence between the N′ and $\gamma$ signals, in coincidence with the N′ signal, opens the gate of the $\gamma$ slow channel and the $\gamma$ pulse is measured with a 100-channel analyzer. A liquid scintillator was used to detect neutrons and an NaI crystal was used for the gamma rays. (M.C.G.)

**29208** THE GENEVA WHOLE-BODY COUNTER. I. CALIBRATION WITH $Cs^{137}$. Pierre Wenger and Kyriacos Soucas (Centre de Radioactivite Medicale, Geneva). Helv. Chim. Acta, 46: 851-4(1963). (In French)

The whole-body counter of Geneva was calibrated for $Cs^{137}$ measurements by using a $Cs^{132}$ standard solution and a $Cs^{137}$ standard solution, furnished by the IAEA. One energy band 150 kev wide from 575 to 725 kev was selected as the $Cs^{137}$ photopeak band. The measurements, made on six cases, yield a calibration factor of 7510 counts per minute per $\mu$C of $Cs^{137}$ in the body. The sensitivity is ±2%. (auth)

**29209** GASEOUS SCINTILLATORS: STRUCTURE, MECHANISM, AND APPLICATIONS. Jean-Louis Teyssier, Daniel Blanc, and Alain Godeau (Centre de Physique Nucléaire, Toulouse). J. Phys., 24: 55-66(Jan. 1963). (In French)

The basic elements of particle detectors using scintillations in a gaseous medium are described and defined: nature and pressure of the gas, impurities, wave length shifter, light reflector, geometry of the chamber. Some remarks are made on scintillations in noble gases, in the liquid or solid states. The essential characteristics of the counter: non-sensitivity to x and gamma rays, fast response, variation of the pulse heights as a function of the energy of the incident particle, resolving power are given. The study of the influence of an electric field upon the scintillation intensity provides information about the fluorescent mechanism. Recent assumptions made about this mechanism are mentioned. A brief survey of the applications of gaseous scintillators to the detection of fission fragments and neutrons is given. (auth)

**29210** SOME REMARKS ON PHOTOGRAPHIC EMULSION. Marie Ader (Collège de France, Paris). J. Phys., 24: 70-1(Jan. 1963). (In French)

The canal along the track of an ionizing particle seen in a nuclear emulsion after development is illustrated. The track of an ionizing particle is longer in a wet emulsion than in a dry emulsion. This is explained by the fact that the stopping power of water is much less than that of the normal emulsion. The transformation of the gelatine into a substance soluble in water by the passage of an ionizing particle is then discussed. A "tunnel" containing the silver particles is formed during development because the soluble gelatine is washed away. Thus the passage of an $\alpha$ particle through an emulsion leaves a "wake" marked not only by a demarcation of the silver grains but also by a sort of "tunnel" appearing after the development of the emulsion. (J.S.R.)

**29211** GEIGER-MUELLER COUNTER WITH GLASS WALLS AND EXTERNAL ELECTRODES FILLED WITH PURE MERCURY VAPOR, OPERATING AT HIGH TEMPERATURE. Jacques Bourrieau (Centre de Physique Nucléaire, Toulouse). J. Phys., 24: 71-3(Jan. 1963). (In French)

The characteristics of a glass-walled G-M counter with external conducting regions filled with pure mercury vapor are studied. The diagram of the counter used is given. The detector operates at saturated vapor pressure. The variations of the counter threshold plateau length, and slope are determined as functions of temperature and vapor pressure. The dead time and restoration time are linear functions of the vapor pressure. The counter behaves as a self-quenching detector, but the same detector filled with argon does not have this characteristic. However, the behavior of the detector is not connected to a classical phenomenon of self-quenching. (J.S.R.)

**29212** DETERMINATION OF THE FLUORESCENCE SPECTRUM OF GASEOUS SCINTILLATORS EXCITED BY LOW INTENSITY α RADIATION. R. Henck and A. Coche (Centre de Recherches Nucléaires, Strasbourg). J. Phys., 24: 166-7(Feb. 1963). (In French)

The spectral distribution of light emitted by the rare gases, Xe and Kr, excited by an α source of several mC was determined. The experimental techniques were described. Kr has an emission band from 2500 to 3800 Å, whereas Xe covers a wider spectral range toward the visible and disappears at 5000 Å. The results are in agreement with those reported earlier using a source 10,000 times stronger. (J.S.R.)

**29213** THE CONTINUOUS ACCUMULATION OF NATURAL β-RADIOACTIVITY WITH THE HELP OF THE FILTER METHOD. J. Terf. Mededel. Koninkl. Vlaam. Acad. Wetenschap., Belg., Kl. Wetenschap., 24: No. 6, 11p. (1962). (In Flemish)

A method is given to obtain the exact mean hourly values of the β-radioactive daughter products of atmospheric radon and thoron, continuously accumulated on a filter. The results are presented in a form which permits a straightforward computation. (auth)

**29214** ABSORBED DOSE CALIBRATION OF AN ION CHAMBER. D. K. Bewley (Hammersmith Hospital, London). Nature, 198: 1318-19(June 29, 1963).

A method for calibrating an ion chamber in terms of absorbed dose is given which avoids the need for corrections for attenuation. The absorbed dose is measured using a carbon calorimeter, a carbon chamber, and a Baldwin-Farmer chamber. The method was used with x-ray beams at 4 to 20 Mv and $Co^{60}$ γ rays. The mean energy per ion pair in air at 0°C 760 mm Hg was determined to be 34.11 ± 0.21 ev in carbon. A graph is given for the rad calibration factor of the Baldwin-Farmer chamber exposed in Perspex. (D.L.C.)

**29215** PHOSPHATE GLASS DOSIMETER FOR ROUTINE PERSONAL DOSE CONTROL IN NUCLEAR TECHNOLOGY INSTALLATIONS. K. Becker (Kernforschungsanlage Julich, Ger.). Nukleonik, 5: 154-9(June 1963). (In German)

The measurement of radioinduced fluorescence (radiophotoluminescence) in silver-phosphate-containing dosimeter glass was proved to be a method superior to that using photographic film for routine control of the radiation burden in nuclear technology installations. Sensitivity, preliminary dose, accuracy, time and temperature effects, energy and direction dependence of various glass-metal filter combinations, and neutron sensitivity, as well as various interfering influences, were investigated, and a capsule was developed for the glass, which can register between about 0.05 and several thousand roentgens as well as about 0.04 to several Mev approximately energy and direction dependent radiation quanta. Special uses and possibilities for improvement are discussed. (tr-auth)

**29216** WATER-RICH EMULSIONS FOR SCINTILLATION COUNTING OF AQUEOUS SOLUTIONS OF β EMITTERS. Gerhard Erdtmann and Guenter Herrmann (Universitat, Mainz). Radiochim. Acta, 1: 98-103(Jan. 1963). (In German)

Equal volumes of aqueous solutions and toluene-scintillator composed of toluene, PPO, and POPOP, form stable emulsions of highly dispersed silicon dioxide and an emulsifying agent are added. Acid concentration of the aqueous phase should not exceed 3N, that of bases 0.1N. Highly concentrated solutions of salts may be emulsified with a dioxane-ethanol-xylene-scintillator and the silica. Maximum counting efficiencies in 20 ml samples containing 50 Nd% of aqueous solution are nearly 100% for β emitters of medium or high energy. $C^{14}$(160 kev) and $H^3$(18 kev) are counted with an efficiency of 40 and 0.35%, respectively. Counting errors compare with those expected from radioactive decay, except if low-energy β radiation is counted. In this case preparation causes an additional error of about ±3% (standard deviation). Because of the high counting efficiency and the large sample volume the emulsions are superior to other liquid counting methods especially in low-level counting. However, low-energy β emitters such as tritium are preferentially counted in homogenous liquid scintillators. (auth)

**29217** TRITIUM COUNTING IN LIQUID SCINTILLATORS WITH P-OLIGOPHENYLS. Gerhard Erdtmann and Guenter Herrmann (Universität, Mainz). Radiochim. Acta, 1: 103-7(Jan. 1963). (In German)

3,3′,2″,3‴-Tetramethylquaterphenyl (TMQP) is a suitable primary solute in liquid scintillators. As wavelength-shifters 3,3′,2‴′,3‴″-tetramethylsexiphenyl (TMSP) or POPOP (1,4-di-[2-(5-phenyl, oxazolyl)]-benzol) can be used. Counting efficiency for tritium in toluene is 30% higher with TMQP-POPOP than with PPO-POPOP. In counting of tritiated water with dioxane-ethanol-xylene-scintillators, PPO (2,5-diphenyloxazol) gives the better sensitivity; but with dioxane-anisol-dimethylglycol the figure of merit is somewhat better if TMQP is used. The latter solvent mixture is recommended to count low specific activities. For $C^{14}$ the counting efficiency is nearly the same with TMQP as with PPO. Studies were made on the effect of secondary solvents in scintillators containing TMQP, PPO, and p-terphenyl; naphthalene interferes with the scintillation process of TMQP. Against quenching by mineral acids, TMQP-scintillators are more resistant than those with PPO. (auth)

**29218** A BETA-GAMMA-RAY COINCIDENCE ARRANGEMENT FOR THE SIEGBAHN-SLÄTIS LKB SPECTROMETER. Hilding Slaetis and Bertil Sigfridsson (Nobel Inst. of Physics, Stockholm). Sci. Tools, 9: 30-5(Dec. 1962).

An arrangement for measuring beta-gamma coincidences in the Siegbahn-Slätis Beta-Ray Spectrometer LKB-3024 is described. The gamma rays are detected by means of a 2″ × 2″ sodium iodide crystal assembly situated in the iron pole piece behind the source. The sample is inserted into the spectrometer through a lock device without destroying the vacuum. The Geiger counter was replaced by a plastic scintillator photomultiplier detector. Disturbances of the pulse-height distributions obtained from the detectors occurred only when the spectrometer was used for beta rays of energies larger than 2.7 Mev, and were completely eliminated by means of compensating coils. The use of the coincidence arrangement is demonstrated on the decay of $Bi^{207}$. (auth)

**29219** PULSE SHAPE DISCRIMINATION WITH HIGH GAMMA BACKGROUNDS. H. G. Dosch, R. Kosiek, K. Maier, M. Schechter, and J. Zimmerer (Universität, Heidelberg). Z. Physik, 174: 222-6(1963). (In German)

Two pulse-shape discrimination circuits for a CsI(Tl) proton spectrometer were tested under high and low gamma background. With low background both circuits behaved equally well, but with high background the circuit proposed by Varga was superior to the circuit according to Owen. (auth)

**29220** A METHOD OF TREATING ANODES FOR GEIGER-MUELLER COUNTERS. Radko Seidl and Milada Kotiková. Czechoslovakia Patent 99422. Apr. 15, 1961.

In order to prevent the spontaneous formation of an oxide layer containing trapping levels on an anode, it is proposed to cover the counter anodes with an oxide layer in the first place, so that this layer should have an accurate stoichiometric composition and adequate thickness, since a considerable quantity of lattice defects arises at the boundary between metal and oxide. The oxidation should be carried out gradually so as to preserve the lattice composition that has been achieved. For a tungsten anode the oxidation is carried out in air at 500°C for 10 minutes, while the cooling down to room temperature takes place at a rate of 10°C per minute. (TCO)

**29221** METHOD AND DEVICE FOR MEASURING THE THERMAL NEUTRON FLUX IN A NUCLEAR REACTOR. (to Atomic Energy of Canada Ltd.). French Patent 1,284,356. Jan. 2, 1962. Priority date Apr. 15, 1960, United States.

For measuring the thermal neutron flux emerging from a neutron source e.g. a nuclear reactor, a neutron detector is arranged in such a way that it receives no essential direct neutron radiation from the source. An element comprising hydrogenized material can scatter to the detector neutrons emitted from the source. The material has a high resistance against radiation and is formed by hydrocarbons, by plastics comprising hydrocarbons and polythene or polystyrene, by paraffin, or by water in a cell or in the form of ice. The scattering element is constituted by two plates arranged in V-form and disposed in angles of 45° with respect to the axis of the beam of neutrons. (NPO)

**29222** MONITOR FOR MONITORING THE RADIOACTIVITY OF A LARGE SAMPLE HOLDER IN WHICH WATER WAS EVAPORATED. H. Kiefer and R. Maushart (to Kernreaktor Bau-und Betriebsges-mbH). German Patent 1,146,986. Apr. 11, 1963. Filed Mar. 25, 1961.

In the patent 1,094,378 a shallow plane proportional counter for measuring very low alpha and beta activities of fluid media is given, which consists of a drum-like housing and of parallel spaced planiform grid electrodes located within the said housing and covering the section of the housing. When monitoring the radioactivity of water, it is desirable to perform the measurement of the gamma activity in addition to and simultaneously with the measurement of the alpha and beta activities. For this purpose, it is proposed to locate a scintillation crystal beneath the proportional counter adjacent to the sample holder. The scintillation crystal is part of a gamma counter which is switched in anti-coincidence with the proportional counter so that the effect of the background radiation can be reduced. (Gmelin Inst.)

**29223** FILTER TAPE TRANSPORT DEVICE FOR MONITORING RADIOACTIVE AEROSOLS. Meinrad Althuser (to Landis & Gyr AG). German Patent 1,147,326. Apr. 18, 1963. Priority date Oct. 24, 1961, Switzerland.

A continuously operated monitoring device is described equipped with a tape of filter paper which is drawn slowly over the air inlet and is monitored later by being passed in front of suitable counters. As the filter paper best suited for this sort of application doesn't normally stand high mechanical stresses, a tape transport device is given which overcomes this disadvantage. This transport device consists of a perforated, flexible transport tape which is drawn over the air inlet of the suction pipe and upon which the filter tape rests. The endless transport tape is wound over two wheels, one of which is a drive sprocket. The filter tape is unwound from a supply drum and rewound on a take-up roll after passing the detector. (Gmelin Inst.)

**29224** POCKET DOSIMETER WHICH CONSISTS OF A IONIZATION CHAMBER, A CONDENSATOR AS VOLTAGE SOURCE AND A CHARGING SWITCH CONTAINED WITHIN A CASE. René Schlappi (to Landis & Gyr AG). German Patent 1,149,116. May 22, 1963. Priority date June 9, 1960, Switzerland.

A pocket dosimeter is described consisting of a case within which an ionization chamber, a condensator as voltage source, and a charging switch are contained. The charging switch is operated by magnetic means. A detailed description of the switch is given. (Gmelin Inst.)

**29225** SPECTROMETER. Hezzie R. Brannon, Jr. (to Jersey Production Research Co.). U. S. Patent 3,090,866. May 21, 1963. Filed June 3, 1957.

A $\gamma$-ray spectrometer for use in well logging, utilizing a combined scintillation-proportional counter, is patented. The spectrometer consists of a large-volume luminophor, which effects essentially total absorption of the energy of incoming radiation, and a photosensitive proportional counter to detect the luminescence produced by the scintillator. The luminophor produces an amount of luminescence proportional to the incoming $\gamma$-ray energy, and an electrical pulse of height proportional to the light from the luminophor is produced by the proportional counter, thus preserving the linearity of the system. The electrical pulses produced are analyzed by conventional apparatus. A spectral analysis of the energies of $\gamma$ rays emanating into a borehole from subsurface formations is thus obtained. (M.P.G.)

**29226** WELL-TYPE IONISATION CHAMBER. Jacques Engelmann (to Commissariat a l'Energie Atomique). U. S. Patent 3,091,716. May 28, 1963. Priority date June 8, 1959, France.

A cylindrical ionization chamber is patented, which has a large volume of uniform sensitivity, within which the ionization current remains constant regardless of the position of the source. The high- and low-voltage electrodes are cylinders coaxial with the wall of the chamber. The distance between the electrodes is made variable along the axis of the chamber, with the distance a minimum in the vicinity of the central region of the chamber. The interelectrode distance may be varied by collars of conductive material attached to the electrodes in adjustable positions, or by one of the electrodes having a curved profile along the axis of the chamber. Details of the design are described and illustrated. (M.P.G.)

**29227** RADIOACTIVITY DETECTION TRAINING. Josef Braunbeck (to Bodenseewerk Perkin-Elmer and Co.). U. S. Patent 3,096,387. July 2, 1963. Filed Apr. 6, 1960.

Training in the detection of high-level radioactivity can be done with a low-level source placed close to a counting tube, the signals of which are amplified and transmitted to a simulated radiation measuring device. Changes in the proximity of the source to the tube simulate changes in the level of radioactivity. One such arrangement is illustrated. (D.C.W.)

**29228** CALORIMETRIC RADIATION DOSIMETER. Roger Lawson Gamble (to Lockheed Aircraft Corp.). U. S. Patent 3,096,440. July 2, 1963. Filed Jan. 22, 1959.

A calorimetric dosimeter for detecting and measuring penetrating radiation consists of a resistance thermometer embedded in a radiation absorber of high density organic material that is surrounded by insulation of the same chemical composition and molecular structure as the absorber, but of a foamed nature. An electric current passed through an Al foil surrounding the insulation provides heat so that the absorber, insulation, and foil have the same tempera-

ture. Thus, the absorber temperature is a true function of the radiation absorbed. (D.C.W.)

**29229** RADIATION SENSITIVE GLASS. Robert Joseph Ginther. U. S. Patent 3,097,172. July 9, 1963. Filed Jan. 31, 1961.

Incorporation of trivalent cerium into certain lithium–aluminosilicate glasses produces glasses that scintillate in response to gamma rays and neutrons. $Li_2O$, $Al_2O_3$, $Ce_2O_3$, and $SiO_2$ are used in specified compositions to give pulse heights of 4 to 14% of the pulse height of a NaI(Tl) crystal. (D.C.W.)

**29230** RADIATION DETECTING APPARATUS OF THE IONIZATION CHAMBER AND SCINTILLATION TYPE. Rodman A. Sharp and Myron S. Eichen (to General Dynamics Corp.). U. S. Patent 3,097,301. July 9, 1963. Filed Sept. 12, 1960.

A conventional gas-flow beta proportional counter combined with a plastic phosphor anti-coincidence umbrella provides a way for measuring radiation from both weak and intense beta sources. The flow counter includes an ionization chamber with a conducting coating on its inner surface to act as the cathode and a loop anode. Coaxial cable is used to establish the potential between the electrodes. A light sensitive device monitors signals from the chamber and scintillator and converts them into electrical signals. (D.C.W.)

# ISOTOPE SEPARATION

**29231** (JÜL-46-PC) PROTOTYP-TRENNELEMENTE FUR EINE MEHRZWECK-THERMODIFFUSIONS-ISOTOPENTRENNANLAGE FÜR GASE. (Prototype Separation Element for a Multiple-Purpose Thermal Diffusion Isotope Separation Plant for Gases). W. Groth, A. Murrenhoff, and H.-H. Bukow (Kernforschungsanlage. Institut für Physikalische Chemie, Jülich, Germany). Feb. 1963. 67p.

With the aim of developing a prototype separation element for use in a multi-purpose thermal diffusion isotope separator, three different types of concentric-tube thermal diffusion columns were constructed. The qualities of these elements were compared to the theory of Jones and Furry as well as to data from columns designed by others. For the maximum differential separative power, favorable values were obtained. Differences between theory and experiment are treated. In testing the reliability, a two-stage cascade was constructed using the prototype columns. The cascade reached equilibrium within 520 hours enriching mass 17 in methane from 1.1 to 20.6% (equilibrium without withdrawal). (auth)

**29232** (TID-18707) SEPARATION DES ISOTOPES DU CALCIUM PAR ELECTROMIGRATION A CONTRE COURANT EN SELS FONDUS. (Separation of the Isotopes of Calcium by Countercurrent Electromigration in Fused Salts). Final Report. F. Menes and G. Dirian (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Dec. 14, 1962. Contract AT(30-1)-2429. 15p.

The results obtained up to June 25, 1962, on the separation of Ca isotopes by electromigration in fused salts have been reported in seven progress reports. The data given in these reports are summarized. Later study investigated the improvement of the diaphragm performance using non-classical methods, preparation of an experiment confirming the performances of the high capacity "U tube" apparatus, and preparation of an installation designed for perfecting the "dropping tube" device. Only preliminary results on these studies are available. (J.S.R.)

**29233** (CEA-tr-A-1316) PROCÉDÉ DE SÉPARATION D'ISOTOPES PAR ÉCHANGE À CONTRE-COURANT DANS UN SYSTÈME D'ÉCHANGE À DEUX TEMPÉRATURES. (Process for Separation of Isotopes by Counter-current Exchange in an Exchange System of Two Temperatures). Kurt Thormann. Translated into French from German Patent 1,097,412. Mar. 7, 1959. 17p.

A countercurrent flow isotope separation system is described, in which the flow takes place in a pair of columns, one of which is "cold" and the other "hot". The two-phase flow may be produced by use of two immiscible liquids, or a gas and a liquid. Separation of deuterium from hydrogen is discussed as an example. (T.F.H.)

**29234** (CEA-tr-A-1331) PROCÉDÉ DE PRÉPARATION D'EAU LOURDE À L'AIDE DE CELLULES ÉLECTROCHIMIQUES. (Process for Preparation of Heavy Water by Means of Electrochemical Cells). Wolf Vielstich. Translated into French from German Patent 1,088,932. May 5, 1959. 9p.

An electrochemical cell for the evolution of $H_2$ is described, in which $H_2$ is evolved from water at one electrode and $H_2$ is evolved from the chemical reaction of an alkali-metal amalgam with water at the other electrode. The use of this second electrode results in increased economy of operation in comparison with a cell in which $H_2$ is evolved at one electrode and $O_2$ at the other. (T.F.H.)

**29235** OPTIMAL CONDITIONS FOR THE TOTAL SEPARATION OF LIGHT ISOTOPES ($C^{13}$, $N^{15}$, AND $O^{18}$) AND THE ARRANGEMENT OF STAGES IN SEPARATION PLANTS. A. Olariu (Inst. of Atomic Physics, Cluj). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 933-8 (1962). (In Rumanian)

The values calculated for obtaining a total separation of light isotopes by extraction or other methods agreed with the results derived for the initial stage. For $C^{13}$, $N^{15}$, and $O^{18}$, the ratio of the flow R (defined as the ratio of the initial flow rate and the extracted flow rate) and the minimum required refluxing $R/R_{min}$ was found to be approximately 1.1. This allows the best extraction system to be chosen and the number of stages to be optimized. A formula was derived for calculating the contribution of the final stages to the over-all cost for stages placed in series, without using dilution sections. For the three isotopes considered it was found that the total cost decreases with increasing number, p, of the stages in the range of $1 \leq p \leq 10$. The contribution of the secondary installations, such as pipelines, liquid transfer apparatus, etc., was not taken into account, but it was estimated that a separation installation consisting of five or six stages represents the optimum system. (TTT)

**29236** THE OPTIMUM REFLUX CONDITION FOR ISOTOPE SEPARATION COLUMNS. A. Olariu (Inst. of Atomic Physics, Cluj). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 939-45(1962). (In Rumanian)

The usually very low natural concentration of the desired isotope ($c \ll 1$) imposes the use of multistage separation plants. The investment and the operating cost are controlled by the first stage, and therefore, the determination of the optimum refluxing conditions of the first stage is very important. If the raw material used is not expensive, the dilution section may be eliminated. The derived values were applied for the case of the distillation of the $H_2O^{16}-H_2O^{18}$ mixture, which has a heavy isotope concentration of $c_1 = 0.204$. Various separation processes, such as distillation, thermal diffusion, diffusion with vapor entrainment, and isotopic exchange with phase conversion, were compared. The results indicated that a criterion similar to the separation cascade may be used. The optimum primary separation is limited by the fact that the separating factor S must fulfill the condition $1 < S_{opt} < 10$. The ratio of the column heights for optimum refluxing and of a column without extraction, under otherwise identical conditions, is about 1.5. (TTT)

**29237** OPTIMUM SEPARATION CONDITIONS IN A THERMAL DIFFUSION COLUMN WITH A HOT WIRE. APPLICATION TO NITROGEN ISOTOPES. Gh. Văsaru (Inst. of Atomic Physics, Cluj). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 947-57(1962). (In Rumanian)

The mathematical treatment of R. Fleischmann and H. Jensen (Ergeb. exakt. Naturwissentschaften 20: 121 (1942)) for determining the optimum conditions for a separation column was simplified, allowing a graphic treatment of the design calculations needed in the design of a thermal diffusion plant. The expressions determining

the optimum conditions for thermal diffusion with a hot wire include geometric parameters of the column together with data on the gas mixture and the prevailing temperature conditions. The data were tabulated for $10 \leq R/r \leq 95$ and r = 0.015, 0.02, and 0.03 cm, where R and r represent the diameters of the column and of the hot wire, respectively. The results were used for calculating the enrichment conditions of $N^{15}$ in natural N isotopic mixture, using a Pt–Ir or Pt–Rh hot wire at a wire temperature of 973°K and a cold-wall temperature of 285°K. Under the assumptions made, the maximum $N^{15}$ concentration is 2.25%. The experimental results were somewhat different from the calculated ones; this is attributed to the simplifying assumptions used. (TTT)

**29238** THE SEPARATION OF SILICON ISOTOPES IN MONOSILANE BY THERMAL DIFFUSION. G. G. Devyatykh and G. K. Borisov (Gorkii State Univ., USSR). Dokl. Akad. Nauk SSSR, 149: 1293-4(Apr. 21, 1963). (In Russian)

The separation of silicon isotopes was carried out by passing monosilane through a metal cylindrically coaxial column 102 cm long with a diameter of 46 mm for the inner cylinder and with a gap width of 2 mm between the cylinders. The inner cylinder was helt at a temperature of 250°C, and the outer cylinder was cooled with water to a temperature of ~15°C. The separation factor F was calculated as the ratio of the isotopic enrichment at the bottom of the column to that at the top of the column: $F = (N_1/N_2)_{bot}/(N_1N_2)_{top}$. The experimental results can be described by the following equations: ln F (for $Si^{30}$) = $(0.134P^2)/[1 + 0.0847P^4]$ and ln F (for $Si^{29}$) = $(0.0645P^2)/[1 + 0.075P^4]$. P is the vapor pressure of the monosilane in atmospheres. A ratio of $K_p/K_c = 1.81$ was found, where $K_c$ is the coefficient for convective mixing, and $K_p$ is the coefficient of parasitic mixing. The theoretical ratio of ln F ($Si^{30}$) to ln F ($Si^{29}$) was calculated as 1.97, while the average experimental value was 1.96. A partial decomposition of the monosilane took place in the earlier experiments, but after the walls became covered with a film of silicon, no further decomposition was observed. (TTT)

**29239** RESULTS OF THE STUDY OF POLPAK PACKING FOR HIGH EFFICIENCY COLUMNS FOR SEPARATION OF ISOTOPES. Anatol Selecki and Bogdan Tymiński (Univ. of Warsaw). Przemysl Chem., 42: 156-61(Mar. 1963). (In Polish)

A description is given of a new polpak packing for laboratory and commercial scale columns. Resistance of flow, separation capacity, and hold-up were studied in dependence on the characteristic size of packing elements, feed rate, and pressure. The packing examined is characterized by high efficiency; the pressure drop per theoretical plate is very low. Therefore the polpak packing is very suitable for distillation under reduced pressure and has many advantages compared to other known packings. (auth)

**29240** METHOD FOR PRODUCING DEUTERIUM WHEN SYNTHESIZING AMMONIA. G. Schaurer and A. Heinzel (to Badische Anilin & Soda-Fabrik AG). German Patent 1,145,585. Mar. 21, 1963. Filed Nov. 18, 1959.

Deuterium can be produced by means of hydrogen exchange reactions between the hydrogen molecules and ammonia in the presence of a catalyst or by means of distillation. The method described is for producing a base material for this process which is already enriched in deuterium. It comprises the steps of separating ammonia, nitrogen, and inert gases from a synthetic ammonia gas mixture which was repeatedly fed to a catalyst system and of producing deuterium by one of the aforementioned means. As could be proved, the deuterium contained in natural hydrogen behaved like an inert gas when submitted to ammonia synthesis so that it was enriched in the residual gases. (Gmelin Inst.)

**29241** METHOD FOR PRODUCING WATER OR HYDROGEN ENRICHED IN DEUTERIUM. Hans Hesky (to Friedrich Uhde GmbH). German Patent 1,147,203. Apr. 18, 1963. Filed Aug. 9, 1956.

A method for producing water or hydrogen enriched in deuterium is given in relation with generating hydrogen by electrolysis of water. The method is based on the fact that in equilibrium the deuterium content in water is higher than the deuterium content in gaseous hydrogen. The method comprises the steps of effecting continuously isotopic exchange in counter current and in the presence of a catalyzer, of circulating the water flowing out of the isotopic exchange device into the electrolytic cell, and of gathering the water or the hydrogen enriched in deuterium on the way from the isotopic exchange device to the electrolytic cell. (Gmelin Inst.)

# MATHEMATICS AND COMPUTERS

*Refer also to abstracts 29072 and 29725.*

**29242** (CEA-2275) CONTRIBUTION A L'ETUDE DE L'EQUATION DE FOKKER-PLANCK. (Contribution to the Study of the Fokker-Planck Equation). A. Blaquiere (France. Institut National des Sciences et Techniques Nucléaires, Paris). 1963. 58p.

The Fokker-Planck equation is presented using the method of Chandrasekhar. Certain conventional resolution methods are given, and then a consideration of the physical interpretation of its various terms leads to a new study method based on the use of Campbell's theorems. This gives a solution to the equation in an integral form. The integral kernel of the solution is a normal centered distribution. Finally, the use of the Laplace transformation leads to a simple determination of the parameters of this integral kernel and connects the present theory to the characteristic function method used in particular in the field of nuclear reactors. The method also makes it possible to calculate the moments of the different orders of the probability distribution without the necessity of solving the FOKKER-PLANCK equation. (auth)

**29243** (CERN-63-21) ON-LINE COMPUTER CONTROL OF THE H.P.D. B. W. Evershed (European Organization for Nuclear Research, Geneva). June 6, 1963. 71p.

In a method of analysis of track-chamber photographs, the H.P.D. was used to digitize the photographs automatically under on-line computer control. The logical design of the control system which enables the IBM 709 Computer to control the various mechanical, optical, and electronic functions of the H.P.D. is discussed. Modifications to circuitry are briefly described. (auth)

**29244** (TID-18948) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. ILLIAC II SYSTEMS PROGRAMMING AND OPERATION. PART III. CIRCUIT RESEARCH PROGRAM. PART IV. MATHEMATICAL METHODS. PART V. DATA REDUCTION METHODS. PART VI. IBM 7090-1401 SYSTEM. PART VII. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). Apr. 1963. Contract [AT(11-1)-415]. 55p.

Developments in the high-speed computer project and in ILLIAC II systems programming are described. ILLIAC II operation is summarized. The transmission line was re-examined, and the propagation of surface waves was found to cause considerable discrepancies between theory and practice. Studies show the broadside coupled strip lines to be more easily handled. Experimental and theoretical work was performed on the avalanche effect. A circuit for measuring accurately the transistor I–V curves was almost completed; preliminary measurements were made. The phase-plane analysis of flipflops was completed. An improved version (FJ-18) of the FJ-17 program for Wiener integral calculations was written, but it did not substantially improve the calculational accuracy. A technique for evaluating Wiener integrals was also studied, and the FJ-17 program was used with Brush's formula to calculate the λ-point in $He_4$ rather well. Developments in data reduction methods are reported. New routines for the IBM 7090-1401 system are listed, along with the specifications of several problems to be handled; and seven problem specifications submitted in April are given. Reliability and utilization of the IBM-1401 and IBM-7090 are summarized. (D.C.W.)

# METALS, CERAMICS, AND OTHER MATERIALS

## General and Miscellaneous

*Refer also to abstract 29085.*

**29245** (AD-406688) PREPARATION AND EVALUATION OF HIGH PURITY BERYLLIUM. Quarterly Progress Report, January 15, 1963–April 14, 1963. G. E. Spangler, M. Herman, E. J. Arndt, D. B. Hoover, V. V. Damiano, and C. H. Lee (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract NOw-62-0536-d. 29p. (Q-B2089-1)

Production of high-purity beryllium and studies of its deformation and fracture characteristics are discussed. Topics covered include zone refining, mechanical testing, swaging, crystal structure, annealing, electron transmission microscopy, deformation, self-diffusion, and gamma absorption. Information is given on the preparation and properties of beryllium–copper alloys. (N.W.R.)

**29246** (AD-407822) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). May 1963. 65p.

A current listing of selected documents and journal articles in an abstracted form on high-strength alloys, light metals, nonmetallics, refractory metals, coatings, applications, and alloys is presented. Author and subject indexes are included. (M.C.G.)

**29247** (BM-RI-6259) METALLOTHERMIC REDUCTION OF YTTRIUM HALIDES. R. E. Mussler, T. T. Campbell, F. E. Block, and G. B. Robidart (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Sept. 1962. Contract AT(11-1)-599. 24p.

An investigation was made of methods to prepare high-purity yttrium metal. Various methods were used to prepare pure intermediate compounds, primarily chlorides, bromides, and iodides, which were subsequently reduced to metal. The process found most suitable for the preparation of pure anhydrous yttrium chloride involved thermal dehydration of a mixture of hydrated yttrium chloride and ammonium chloride while under vacuum. Yttrium bromide and iodide were prepared most effectively by the direct halogenation of yttrium carbide. Yttrium carbide was obtained by reacting and melting yttrium oxide–carbon mixtures in a carbon-arc furnace. Yttrium halides were purified by vacuum distillation and reduced by alkali or alkaline-earth metals. Lithium and sodium proved to be the best reductants from the standpoint of yield (>95%) and purity (>99.8%) of the yttrium. The product of the reduction step was sponge metal, which was consolidated readily by conventional cold-mold, arc-melting procedure. The purest yttrium obtained in laboratory scale work was prepared by sodium reduction of yttrium chloride and contained only 125 ppm oxygen; other impurities did not exceed 1,000 ppm. In larger scale tests yttrium containing only 800 to 1,000 ppm total impurities was obtained by lithium reduction of yttrium chloride. The tensile properties of high-purity yttrium were determined. Mechanical tests showed that yttrium can be forged, extruded, rolled, spot welded, and deep drawn. (auth)

**29248** (CEA-2267) DISPOSITIF EXPERIMENTAL POUR LA MESURE DE FAIBLES COEFFICIENTS DE DIFFUSION PAR LA METHODE DE SECTIONNEMENT. (Experimental Device for the Measurement of Low Diffusion Coefficients by the Sectioning Method). W. J. Deiss (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1963. 16p.

Equipment for investigating, by a technique based on abrasion, diffusion couples prepared according to the principle of the two semi-infinite media or a sample on which an infinitely thin layer of diffusing material has been deposited is described. A system for aligning the interface, a precision grinder, and a micrometer for thickness measurements are involved. Diffusion coefficients down to $10^{-14}$ $cm^2/s$ can be measured accurately. (auth)

**29249** (DRI-2090) AN INVESTIGATION OF THE EFFECT OF METALLIC ADDITIONS UPON THE OXIDATION RESISTANCE OF TITANIUM-MODIFIED $NbAl_3$. Quarterly Progress Report No. 2, December 1, 1962–February 28, 1963. Walter Wheatfall (Denver. Univ. Denver Research Inst.). Mar. 1963. Contract AT(11-1)-1092. 11p.

The air–oxidation resistance of titanium-modified $NbAl_3$ with alloy additions of tin was investigated. Thermogravimetric determinations of the weight gain/$cm^2$ in air over a 24-hr period were made on arc-melted alloys at 760 to 1360°C. Phase equilibria studies of the alloys after homogenization and isothermal annealing at 1300 and 1000°C are also being conducted to supplement the oxidation studies. Oxidation data for two tin-addition alloys are presented. (auth)

**29250** (GEST-2012) NOTES ON LIQUID METAL STUDIES IN FRANCE AND GREAT BRITAIN. Leo F. Epstein (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Oct. 1, 1962 (Revised Jan. 15, 1963). Contract NASr-108. 30p.

A summary of observations made in laboratories engaged in liquid metal work in Great Britain and France during a visit made in the summer of 1962 is presented. Many of the problems being examined are identical with those which were encountered in U. S. research. Particular attention was devoted to presenting names and addresses of British and French workers in this field and to calling attention to European ideas and techniques which would appear to be of direct interest and concern to the U. S. program. (auth)

**29251** (LADC-5785) METALLOGRAPHY OF POWDER MATERIALS. T. I. Jones (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 24p.

A metallographic method for examination of powder materials is described. It was used principally for the initial evaluation of particle size, relative size distribution, particle shape, density, the degree of agglomeration and the presence of extraneous phases. A small quantity of powder is mixed in an epoxy-filled metal cylinder which, after the resin hardens, is remounted in a longitudinal direction and the section polished. Figures are presented illustrating some of the materials that were examined. (M.C.G.)

**29252** (MSAR-63-91) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report No. 33, May 1963. (MSA Research Corp., Callery, Penna.). June 21, 1963. Contract AT(11-1)-765. 46p.

Tests to determine the physical properties of Type 316 stainless steel and 2¼ Cr–1 Mo steel specimens in low oxide Na, He, and air at 1200 and 1100°F, respectively,

were completed except for three Type 316 SS and two Cr–Mo steel creep tests in He, one Type 316 SS creep-to-rupture test in He, and two pre-exposed Cr–Mo steel creep-to-rupture tests in air. Metallurgical examination of the specimens generated in these tests is continuing. Preliminary conclusions based on the results are presented. A comparison between the incomplete physical property data and the environment in which the specimens were run indicates that for Type 316 stainless steel at 1200°F the creep rates in He and Na are higher than in air and the number of cycles to failure in fatigue is extended by He followed by Na as compared with air. However, at low strains all three environments may show equal life. All other physical properties showed little effect. For 2¼ Cr–1 Mo steel at 1100°F the tensile strength was lower in He than in air and the stress-rupture strength in Na was slightly lower than for He or air. Pre-exposing the specimens for 4000 hr (in Na) lowered the stress-rupture strength. The creep rate in Na is higher than in air. The number of cycles to failure in fatigue is extended by both He and Na. The effect of He on creep is too premature for a comparison. It is noted that some of the differences occur in a relatively short time, indicating possible surface effects. Thermodynamics will be used to determine whether the different $O_2$ contents of the various environments may affect surface compositions. The determination of the physical properties of 316 SS specimens in 1200°F Na saturated with C is planned. The measurement of the physical properties of 2¼ Cr–1 Mo steel specimens in Na having 200 to 300 ppm sodium oxide is in progress. (auth)

**29253** (NRC-7129) A REVIEW OF THE REFRACTORY METALS. R. Smallman-Tew (National Research Council of Canada. National Research Labs., Ottawa). Nov. 1962. 42p. (LR-358(NRCC))

A need exists for structural materials capable of operation at 2000°F and higher. Because these operating conditions are beyond the capabilities of the nickel- and cobalt-base alloys, attention is focussed on the refractory metals, chromium, niobium, molybdenum, the platinum group, tantalum, tungsten, and vanadium. The review covers the availability of the ores and concentrates from which the refractory metals are obtained, particularly those of Canadian origin. It also deals with the principal mechanical and oxidation properties of these metals, and their methods of fabrication and processing. (auth)

**29254** (SCTM-130-63(74)) NEW HEAT SOURCES AND TECHNIQUES FOR USE IN VACUUM DEPOSITION OF THIN FILMS. C. M. Stover (Sandia Lab., Albuquerque, N. Mex.). June 1963. Contract [AT(29-1)-789]. 13p.

Heating sources and methods developed for evaporating materials in vacuum are discussed. These techniques allow flexibility in the deposition of films in a variety of setups. An advantage in using these methods is that multiple operations can be accomplished during one pump-down of the vacuum coating system. (auth)

**29255** (ZFK-WF-13) VERTRÄGLICHKEIT VON SPALTSTOFFEN MIT KONSTRUKTIONSWERKSTOFFEN. TEIL I. VERTRÄGLICHKEIT VON METALLISCHEN SPALTSTOFFEN MIT HULLENWERKSTOFFEN. (Compatibility of Fissionable Materials with Construction Materials. Part I. Compatibility of Metallic Fissionable Materials with Cladding Materials). Heinz-Eberhard Roellig (Germany. Zentralinstitut für Kernphysik, Dresden). Mar. 1962. 91p.

The compatibility of uranium, plutonium, and thorium with aluminum, zirconium, magnesium, beryllium, titanium, ferreous metals, and refractory metals is summarized. Preparation of samples and assemblies, annealing procedure, and examination of reaction zones are described. Results of the different investigators (diffusion and penetration coefficients, activation energies, etc.) are analyzed and discussed. (auth)

**29256** (AEC-tr-5833) DETERMINATION OF THE NUMBER AND SIZE OF PARTICLES EXISTING IN A MATERIAL. Jiri Likes. Translated from p.59-67 of "Proceedings of the Conference on Applications of Mathematics in the Engineering Industry, Prague, 1962." 8p.

Due to the opacity of metal specimens, it is impossible to determine directly the actual (spatial) size of particles and their number per unit volume of the sample. Therefore, measurements of particle cross sections in the plane of the metallographic microsection are made on the one hand, and from measurements of the dimensions and number of particles contained in a unit volume on the other hand. These relations depend on the geometric shape of the particles, and their distribution and orientation in the bulk of the specimen. Several relations are derived for particles of such shape that it is possible to replace them easily by spheres without essential error. By choosing spherical particles, the problem of their orientation is eliminated. As to the arrangement of the particles, a random (uniform) distribution in the bulk of the specimen is assumed. (N.W.R.)

**29257** ON THE THEORY OF SINTERING REFRACTORIES. N. F. Kozinskii (Kiev Polytechnical Inst.). Dopovidi Akad. Nauk Ukr. RSR, No. 4, 522-4(1963). (In Ukrainian)

To improve the thermal and other important properties of refractories, a method of volume sintering, differing in principle from film sintering, is presented. Instead of using two chemically different materials for the basic oxide and liquid phase of the refractory, as in the case of film sintering, only one material is used, the quantity of liquid phase being the same in both phases. Using the volume form of sintering under industrial conditions in the production of multichamotte refractory for the shaft of a blast furnace, refractory was obtained having better properties than the previously manufactured refractory. (auth)

**29258** FABRICATION AND PROPERTIES OF EXTRUDED AND SINTERED BeO. B. A. Chandler, E. C. Duderstadt, and J. F. White (General Electric Co., Cincinnati). J. Nucl. Mater., 8: 329-47(May 1963). (In English)

This work describes the fabrication of BeO specimens of six compositions at three porosity levels with varying grain size, and shows the effects of composition and microstructure on the mechanical and physical properties. Three grades of BeO were used: UOX, a sulfate-derived high purity BeO; HPA, a hydroxide-derived high purity BeO; and AOX, a somewhat less pure grade of BeO. The UOX grade was also prepared with additions of 0.5 weight percent MgO or 3.0 weight percent $ZrO_2$ and the HPA with additions of 0.5 weight percent MgO. The impurities present, particle size by electron micrographs, x-ray crystallite size, and particle distribution of the BeO used are given. Impurity contents were also determined after sintering. All six compositions were prepared in the porosity range of 2 to 3 percent and having a nominal average grain size of 20 microns. Three of the six compositions, UOX 0.5 weight percent MgO, AOX, and HPA were prepared in three porosity ranges (2 to 3%, 7 to 8.5%, and 12 to 14%) and in as many as six nominal average grain sizes (5, 10, 20, 50, 80, and 100 microns). Most of the samples were fabricated

by extrusion of a dispersion of a powder mixed with an organic plasticizer but for comparison purposes, some were prepared by isostatic pressing. The samples were dried, prefired in air at about 1000°C to remove most of the organic matter, and sintered in a hydrogen atmosphere. Methods such as adding an organic "filler" or varying the time and temperature of the sintering cycle were used to achieve a given porosity and grain size. The effect of time, temperature, and additives on the density and grain growth are shown in tables and charts. The UOX grade BeO was the only grade that showed evidence of preferred orientation of crystallites in the extruded and sintered rods; however, no evidence of preferred orientation was found when specimens of UOX grade BeO were prepared by isostatic pressing and sintering. Pores were studied by electron microscopy and were found to give reflections of the crystal habit. The effect of porosity, grain size, and temperature on elastic moduli, modulus of rupture, compressive creep, lattice parameters, and thermal expansion are given. The correlation between the elastic moduli and porosity were found to be statistically significant for the ranges stated and these results are expressed as empirical equations. In addition, increasing orientation of the C-axis along the longitudinal axis of the specimen causes the elastic moduli to increase. Modulus of rupture data are presented which show the effect of grain size, porosity, composition, and temperature. Compressive creep for several combinations of composition, grain size, and porosity was measured in dry air at 1200°C for 500 hours at loads from 1000 to 10,000 psi, and the data are correlated with the Nabarro-Herring relationship. (auth)

**29259** THERMAL ETCHING VACUUM. Jan Truchlý (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 9: 156-61(1963). (In Czech)

The article deals with the methods of thermal etching of metallographic sections in vacuum, and with the application of this method to uranium section preparation. Experimental evaluation of this method, the determination of optimum conditions for uranium section preparation, and practical application possibilities of this method are reported. (auth)

**29260** ANNEALING OF PYROLYTIC GRAPHITE UNDER PRESSURE. A. R. Ubbelohde, D. A. Young, and A. W. Moore (Dept. of Chemical Engineering and Chemical Tech., London). Nature, 198: 1192-3(June 22, 1963).

It was found that the use of pressure in conjunction with heating of pyrolytic graphite disks results in the c axes being oriented within a narrow range (0.5° dispersion) and a density identical to that of single crystals. A pressure of 400 to 500 kg/cm$^2$ is applied uniaxially in the c-axis direction while the disks are heated to around 2800°C. (D.L.C.)

**29261** SYMPOSIUM ON EFFECTS OF SPACE ENVIRONMENT ON MATERIALS, ST. LOUIS, MAY 7, 8, AND 9, 1962. (Society of Aerospace Material and Process Engineers). 521 p. $6.00. (Western Periodicals Co., Hollywood, Calif.).

Twenty-two papers presented at the National Symposium on the Effects of Space Environment on Materials are given. Separate abstracts were prepared for 11 of the papers. One was previously abstraced for NSA. (M.C.G.)

**29262** THE EFFECT OF AEROSPACE ENVIRONMENTS ON VIBRATION DAMPING TECHNIQUES AND MATERIALS. D. M. Forney, Jr. and W. J. Trapp (Aeronautical Systems Div., U. S. Air Force). 24p. of "Symposium on Effects of Space Environment on Materials."

The effects of elevated temperature, the near vacuum of space, and radiation on damping systems involving the effective coupling of both metallic materials of vehicle construction and viscoelastic damping polymers are discussed. (M.C.G.)

**29263** THE EFFECTS OF HIGH VACUUM AND RADIATION ON POLYMERIC MATERIALS. Norman E. Wahl and John V. Robinson (Bell Aerosystems Co., Buffalo). 28p. of "Symposium on Effects of Space Environment on Materials."

Space vehicles and their component materials will be exposed to environmental conditions of greatly reduced pressure, intense electromagnetic radiation, high energy particles, protons and electrons, in interplanetary space. Experimental studies that were conducted to determine the effects of heat, low pressure, and radiation on plastics and elastomeric materials are described. (M.C.G.)

**29264** FABRICATION OF FOAMED POLYURETHANE STRUCTURES IN A SPACE ENVIRONMENT. Sidney Allinikov (Wright-Patterson AFB, Ohio) and Seymour Schwartz. 21p. of "Symposium on Effects of Space Environment on Materials."

Several approaches to solution of the difficulties associated with producing chemically foamed-in-place polyurethanes at reduced atmospheric pressures are discussed. Advantages and drawbacks of the various polyurethane foam reactant systems explored are discussed. The preliminary development of a one part solid reactant polyurethane foam system and its implications are presented. Suggested applications for polyurethane foam in an aerospace environment are submitted. (auth)

**29265** FLUOROCARBON PLASTICS UNDER THE INFLUENCE OF UNUSUAL ENVIRONMENTAL CONDITIONS. Robert P. Bringer (Minnesota Mining and Mfg. Co., St. Paul). 22p. of "Symposium on Effects of Space Environment on Materials."

The fluorocarbon plastics, already known for their chemical inertness and temperature resistance, are reviewed in light of available data taken under exposure to unusual conditions. A description of the chemical nature and general properties of the commercially important fluorocarbon plastics is given. The effects of high and low (cryogenic) temperatures, exposure to liquid oxygen, γ and x radiation in air and in vacuum, ultraviolet radiation, and vacuum exposure are described. (auth)

**29266** THE EFFECT OF SPACE ENVIRONMENT ON REINFORCED PLASTICS. Leo E. Gatzek (Aerospace Corp., El Segundo, Calif.) and Lionel Isenberg. 46p. of "Symposium on Effects of Space Environment on Materials."

The role of reinforced plastic composite systems in future aerospace applications is reviewed with particular emphasis on space structures. Examples of unique plastic molding, filament-winding, and laminating techniques as applied to aerospace structures are presented. Effects of the aerospace environment on reinforced plastics and probable ways of improving these materials commensurate with future requirements are discussed. The outlined information is used to establish a factual basis for predicting the future space applications of reinforced plastic material systems within realistic limits. (auth)

**29267** THE EFFECT OF GAMMA RADIATION ON STRUCTURAL ADHESIVE JOINTS. R. M. McCurdy and G. M. Rambosek (Minnesota Mining and Mfg. Co., St. Paul). 12p. of "Symposium on Effects of Space Environment on Materials."

The effect of gamma radiation on the performance of several structural adhesive bonds was measured. It was concluded that: nitrile-phenolic adhesives are more resistant to radiation damage than epoxy-based adhesives; the peel strength of adhesives deteriorates more rapidly than other properties; and thick adhesive layers retain useful strength better than thin glue lines. (auth)

**29268** SOME RADIATION EFFECTS IN GaAs. L. W. Aukerman and R. D. Graft (Battelle Memorial Inst., Columbus, Ohio). 25p. of "Symposium on Effects of Space Environment on Materials."

The known radiation effects in GaAs are summarized and, when possible, comparisons with other device materials are made. The annealing behavior of n-type GaAs irradiated at room temperature with 1-Mev electrons suggests that the defects produced do not form complexes with impurity atoms. This is contrary to the behavior of radiation-produced defects in germanium and silicon, which are known to form complexes with certain impurities. The rate of annealing in n-type GaAs is dependent on the carrier density, but this can be explained in terms of the effect of Fermi level on the mobility of defects. The 1-Mev electron damage can be completely annealed at about 220°C in n-type GaAs and at about 350°C in p-type material. In the case of neutron irradiation of GaAs, where the probability of creating clusters, or damaged regions, is greater than in the case of charged particles, the damage could not be completely removed by annealing although annealing temperatures as high as 600°C were tried. These results are discussed in terms of a radiation-damage model. (auth)

**29269** THE EFFECTS OF SPACE RADIATION ON ELECTRONIC COMPONENTS. Donald J. Hamman (Battelle Memorial Inst., Columbus, Ohio). 11p. of "Symposium on Effects of Space Environment on Materials."

Semiconductors were studied under simulated space radiation environment, i.e., proton and electron bombardment. Effects on other types of electronic components are estimated by comparison. (auth)

**29270** LUBRICATION IN SPACE ENVIRONMENTS. R. L. Adamczak, R. J. Benzing, and H. Schwenker (Aeronautical Systems Div., USAF). 12p. of "Symposium on Effects of Space Environment on Materials."

Solid, semi-solid, and liquid lubricants, hydraulic fluids, heat transfer fluids, and novel lubrication techniques are discussed with respect to the current state-of-the-art and the future capabilities of these various materials and/or their application. The severe environmental conditions of space are compared against both the current and future state-of-the-art in the field of lubrication and energy transfer media. Research efforts currently being pursued to provide new and improved lubricants are described. A brief interpolation is also given of the overall lubricant picture with respect to space technology in terms of reliability and system design. (auth)

**29271** A CRITICAL APPRAISAL OF MATERIALS TESTING. Henry E. Frankel (Goddard Space Flight Center, Greenbelt, Md.). 13p. of "Symposium on Effects of Space Environment on Materials."

An evaluation of tests of effects of space environment on materials is presented. The most prevalent type of testing being carried out is a "before exposure–after exposure" experiment, with the specimens generally being tested in an "earthly" atmosphere after exposure to the space environment. As a consequence, the true effects of a space environment on materials is not known. Examples illustrating the comparative effects of testing in a space environment as opposed to testing in a laboratory after exposure are presented. (auth)

**29272** BEARINGS FOR VACUUM OPERATION–PHASE I. Harold E. Evans and Thomas W. Flatley (Goddard Space Flight Center, Greenbelt, Md.). 30p. of "Symposium on Effects of Space Environment on Materials."

The initial phase of an investigation of the high speed operation of miniature ball bearings, with metallic film lubrication, in a vacuum environment is described. Phase I of this study was conducted to determine the most promising retainer material and design for use in a general study of the effectiveness of various metallic coatings as lubricants. Fully machined retainers of five different materials, with all balls and races of gold plated 440C stainless steel, were tested. Both pure gold plating and gold with additives were investigated. Size R2-5 bearings were run without external loading at a nominal motor speed of 10,000 rpm and the goal is a bearing life of 1,000 hours in an ambient pressure of $10^{-7}$ torr. The results show that: thin metallic films as lubricants show real promise when used in a vacuum environment; pure gold plating is not as effective as the plating with additives; fully machined retainers provide good performance; the use of relatively hard retainer materials significantly extends the useful life of the bearings; and the bearing failures tended to be catastrophic rather than gradual, making the prediction of the onset of failure difficult. A special multi-port oil-free vacuum system designed and built for this program proved extremely effective in achieving a vacuum of $10^{-7}$ torr, and in permitting the operation of seven individual tests at one time. (auth)

**29273** IMPROVEMENTS IN OR RELATING TO EUROPIUM-CONTAINING ALLOYS AND NUCLEAR REACTOR CONTROL RODS MADE THEREOF. (to W. C. Heraeus GmbH). British Patent 925,240. May 1, 1963. Priority date Apr. 9, 1960, Germany.

A silver-base alloy containing 0.5 to 35% by weight Eu is patented. The Ag content of the alloy should be at least 65%. The alloy may also contain Cd, In, Au, Pd, and Pt. The Ag content of the alloy may be reduced to not less than 55% when 0.1 to 10% of Au, Pd, and/or Pt are added. The alloy may be prepared by melting the metals in a Ta crucible under reduced pressure at a temperature between 650 and 900°C, casting the molten metal into a graphite crucible under an Ar atmosphere, cooling the bars or ingots, and then heating them to 450°C for several hours. Reactor control rods may be manufactured from the bars or ingots by the usual shaping methods. (M.P.G.)

**29274** IMPROVEMENTS IN METHODS OF HYDRIDING ZIRCONIUM AND ZIRCONIUM ALLOYS. (to General Dynamics Corp.). British Patent 925,916. May 15, 1963. Priority date June 9, 1960, United States.

A method of uniformly hydriding solid pieces of Zr and Zr alloys of substantial size without cracking is patented. Solid metal containing at least 50% by weight of Zr is heated in an evacuated chamber to a temperature of at least 700°C. Hydrogen is introduced into the chamber in very small increments and at a very slow rate of pressure build-up, so that hydriding in a given phase of the H–Zr system is essentially completed before substantial hydriding in the next successive phase is obtained. Hydriding is completed in the gamma Zr phase, and the hydriding temperature is lowered while H is still being introduced in small increments. The resulting hydrided pieces of pre-

determined size and shape are ready for immediate use without shaping operations. (M.P.G.)

**29275** ELECTROLYTIC PROCESS FOR THE PREPARATION OF PURE METALS IN COMPACT FORM AND AN APPARATUS FOR CARRYING OUT THE PROCESS. (to European Atomic Energy Community (Euratom)). British Patent 926,724. May 22, 1963. Priority date Dec. 28, 1960, Germany.

An electrolytic process for the preparation of pure metals, using a salt melt of the metal as electrolyte, is patented. The process can be used for all metals that are plastically deformable at temperatures below the associated temperature of their electrolytic salt melt, including Ta, Th, Pu, U, Ti, Nb, Zr, Hf, Be, and the rare earth elements. During electrolytic precipitation, under nonoxidizing conditions, of the metal on the electrode, the formation of a dendritic structure is inhibited by repeated application of mechanical pressure to the deposit surface. This produces a compact, inclusion-free metal layer. Various designs for the apparatus to carry out the process are described. (M.P.G.)

**29276** PHOTOSENSITIVE GAS PHASE ETCHING OF SEMICONDUCTORS BY SELECTIVE RADIATION. Joseph R. Ligenza (to Bell Telephone Labs., Inc.). U. S. Patent 3,095,332. June 25, 1963. Filed June 30, 1961.

A method for fabricating diffused semiconductor devices and for shaping a resistant overlayer for controlling a subsequent diffusion of significant impurities into a semiconductor substrate is presented. The method is based on the fact that $IF_5$ is particularly sensitive to appropriate radiation in the form of $F_2O$. Examples of the technique are described. (P.C.H.)

**29277** PHOTOSENSITIVE GAS PHASE ETCHING OF SEMICONDUCTORS BY SELECTIVE RADIATION. Joseph R. Ligenza (to Bell Telephone Labs., Inc.). U. S. Patent 3,095,341. June 25, 1963. Filed June 30, 1961.

The equipment and process is described for selectively etching a diffusion resistant overlayer for leaving a diffusion-resistant mask of prescribed configuration suitable for monitoring a subsequent diffusion of impurities into a semiconductor substrate. The process is based on the discovery that a radiation pattern incident upon a surface disposed in a particular gaseous ambient including gases such as $NF_3$ and $Br_2$ can be made to stimulate etching only in the shadowed areas of the surface. In one specific application of the process $NF_3$ is bubbled through liquid bromine at room temperature and atmospheric pressure and the resulting gaseous mixture is introduced at normal operating temperatures to an inert enclosure equipped with a window that is transparent to radiation of suitable wavelengths. A silicon semiconductor wafer coated with an overlayer of thermally grown silicon dioxide is disposed in the enclosure and a mask is placed in contact with the wafer appropriately disposed with respect to a suitable radiation source so that the mask shadows the portion of the coating desired to be removed and thereafter the assembly is irradiated by the source. This results in selective etching only of the shadowed portions of the oxide coating. (P.C.H.)

**29278** FUELS FOR NUCLEAR REACTORS. Samuel W. Martin (to Great Lakes Carbon Corp.). U. S. Patent 3,097,151. July 9, 1963. Filed Sept. 30, 1957.

Dispersion of fissionable material in coke stock or graphite flour; mixing the product with a binder; and molding, baking, and graphitizing (coke mixture) the resultant product gives a reactor fuel with a uniform distribution of fissionable material. The fuel can be cast into blocks for use in a Fermi graphite-block reactor or into pellets and spheres for continuous reactors. (D.C.W.)

## Corrosion

*Refer also to abstract 29777.*

**29279** (BMI-X-227) CORROSION RESISTANCE OF NICKEL-BASE ALLOYS IN A $NaF-LiF-BeF_2-ZrF_4$ SALT MIXTURE UNDER HYDROFLUORINATOR CONDITIONS WITH ZIRCALOY-2 DISSOLVING AT 500 C. P. D. Miller, E. F. Stephan, W. N. Stiegelmeyer, and F. W. Fink (Battelle Memorial Inst., Columbus, Ohio). Apr. 25, 1963. Contract W-7405-eng-92. 13p.

A study was made to evaluate the corrosion resistance of nickel alloys in $NaF-LiF-BeF_2-ZrF_4$ salt mixtures at 500°C with Zircaloy-2 dissolving in the melt. The assembly was operated for 200 hr, and 293.15 g of Zircaloy-2 was added. The corrosion attack was apparently very mild; even the liquid-vapor interface area was barely discernible, and no reduction in thickness could be detected. (M.C.G.)

**29280** (GEAP-3726) SODIUM MASS TRANSFER. II. SCREENING TEST DATA AND ANALYSIS. VOLUME 2. METALLURGY. F. J. Hetzler and R. S. Young (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). June 1962. Contract AT(04-3)-189. 59p.

Results obtained in initial screening runs on sodium mass transfer are summarized for three steels. Where results depend upon bimetallic material combinations, the specific combination is indicated. The 2½ Cr–1 Mo steel decarburized at 1000 to 1200°F in both monometallic and in bimetallic 316SS–2¼ Cr–1 Mo systems. The decarburization process was found to increase with increasing oxygen levels in the sodium and by providing a carbon sink. Limited tensile data indicated that strength of the material significantly decreased with the loss of carbon. The shape of the carbides probably was significant since higher tensile strengths were encountered when the carbides were formed in a pearlite phase than when the carbides existed in spheroidized form. A reduction of approximately 30% in room temperature tensile strength was indicated by the data. Carbide-stabilized 2¼ Cr–1 Mo alloys, 4S4 and 4S8 were approximately neutral to carbon transport in 700 hours in a bimetallic 316SS–2¼ Cr–1 Mo system. No serious localized effects were observed in this alloy group. For 5 Cr–½ Mo–Ti steel intergranular penetration of corrosion products was observed in the 1000 to 1200°F temperature regions to a maximum depth of 0.001-inch in approximately 2800 hours. The layer where the phenomenon occurred was found to be chromium depleted. This penetration can result in lower strength properties particularly in the case of components with stress-concentrations. Depths of penetration were minor but longer times than 2800 hr at low sodium velocities might enhance the effect and cause significant reductions in stress-rupture strength and hasten inter-crystalline cracking. The alloy was approximately neutral to carbon transport, both in a monometallic and in a bimetallic 316SS–5 Cr–½ Mo–Ti system. The 316 stainless steel was approximately neutral to carbon transport in a monometallic system, but carburized in a bimetallic 316SS–2¼ Cr–1 Mo system. The degree of carburization was limited by the apparent inability of 316 stainless steel to accept carbon as readily as the ferritic alloy lost carbon. An increase in carbon content slightly in excess of twice the as-received value of 0.045% was observed. This can be expected to cause some

increase in mechanical properties, and tensile and yield strength. The effects of microstructure of carbon increase were not completely evaluated; however, in areas of worked structure heavier carbide cases and precipitation of carbides along preferred crystallographic planes, termed Widmanstätten structure, were observed. These effects indicate possible susceptibility to local embrittlement. An austenitic-to-ferritic transformation occurred at the surface at temperatures of 1100 to 1300°F. This transformation was observed to begin in 700 hours and was enhanced in regions of deformed structure. A surface structure anomaly was also observed at 1000°F in 700 hours which may be the initiation of the transformation. Chromium depletion was observed adjacent to the surface in the area where these effects took place. (auth)

**29281** (MSAR-63-57) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. Progress Report No. 31, March 1963. (MSA Research Corp., Callery, Penna.). Apr. 12, 1963. Contract AT(11-1)-765. 33p.

The effects of air, helium, and sodium on creep-rupture, creep rate, and fatigue of type 316 stainless steel and 2¼-chromium–1-molybdenum steel at 1100 and 1200°F are evaluated. Modifications to the test loops are discussed and shown. Analytical results of carbon and carbonate content in the test specimens are presented. The results of metallurgical examination are given. (N.W.R.)

**29282** (ORNL-TM-539) A SURVEY OF THE CORROSION OF MARTENSITIC AND FERRITIC STAINLESS STEELS IN PRESSURIZED WATER. R. J. Beaver and C. F. Leitten, Jr. (Oak Ridge National Lab., Tenn.). July 16, 1963. Contract W-7405-eng-26. 34p.

The corrosion resistance of martensitic and ferritic austenitic stainless steels and carbon steels in pressurized water at 500 to 600°F is compared. Included are specific out-of-pile data for austenitic stainless steels, AISI types 302, 303, 304, 304L, 316, and 347; the martensitic AISI types 410, 420, 431, and 440C; the ferritic AISI types 430, 442, and 446; the precipitation-hardening type 17-4PH; and carbon steels, ASTM 212 A and B. Available corrosion results obtained under irradiation at exposures in the range of $7 \times 10^{18}$ to $3 \times 10^{19}$ nvt are also included for types 304, 347, 410, 431, and 442. With the exception of type 431, the types of martensitic and ferritic stainless steels which were evaluated do not contain nickel. For application where it is desirable to minimize $Co^{58}$ activity produced from nickel, selection of a martensitic or ferritic stainless steel may be more appropriate than choosing the more popular nickel-bearing austenitic stainless steel or a fuel-element cladding material. Interpretation of the data indicates that, on the average, martensitic and ferritic stainless steels corrode more rapidly than austenitic alloys but more slowly than carbon and low-alloy steels. Under selected controlled water conditions or under irradiation, the corrosion of the nickel-free stainless steels appears to differ little from the austenitics. The corrosion of martensitic and ferritic stainless steels in pressurized-water systems therefore does not appear of such magnitude as to rule out development of these materials as the cladding fuel elements for specific applications. (auth)

**29283** (TID-17257) CORROSION OF WELL POINTS AND WELL PIPING IN DOMESTIC WATER ADJACENT TO THE SAVANNAH RIVER PLANT. E. C. Hoxie (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1962. Contract AT(07-2)-1. 17p.

An investigation was made to determine the cause of excessive corrosion of construction materials of wells supplying domestic water to several families in communities bordering the Atomic Energy Commission's Savannah River Plant in South Carolina. The excessive corrosion was a result of the natural corrosiveness of soft water with high carbon dioxide and oxygen contents. Nothing was observed that would indicate in any way that the activities of the Savannah River Plant have contributed the failures. (auth)

**29284** (TID-18952) CORROSION CHARACTERISTICS OF THE RARE EARTH AND YTTRIUM METALS. Linda Lee and Norbert D. Greene (Rensselaer Polytechnic Inst., Troy, N. Y.). [nd]. Contract [AT(30-1)-1995]. 29p.

The corrosion of rare earth metals in air, water, and aqueous solutions at different temperatures was measured by conventional weight-loss and weight-gain tests. The metals oxidize slowly in air, corrode slowly in water and alkaline solutions, and are readily soluble in most acids. Correlations of corrosion behavior with the electronic and physical properties of the rare earths are discussed. (auth)

**29285** THE STRUCTURE OF ANODIC FILMS. I. AN ELECTRON DIFFRACTION EXAMINATION OF THE PRODUCTS OF ANODIC OXIDATION ON TANTALUM, NIOBIUM AND ZIRCONIUM. P. H. G. Draper and J. Harvey (Imperial Coll., London). Acta Met., 11: 873-9(Aug. 1963).

Electron diffraction showed the anodic films formed on Ta and Nb in dilute $HNO_3$, $H_2SO_4$, $Na_2SO_4$, 100% $H_2SO_4$, $H_3PO_4$ to be amorphous and probably consisting of the pentoxides, to which they crystallize on heating. However the stripped amorphous film obtained by anodization in saturated $Na_2SO_4$ at room temperature crystallized on heating to a different structure. This appears to be a compound of $Na_2O$ and $Ta_2O_5$ with a perovskite structure, having less $Na_2O$ than required for $NaTaO_3$, indicating that electrolyte had been taken up during growth. With Zr also the film structure was found to depend on the electrolyte used. In 10% $HNO_3$, $H_2SO_4$ the film is crystalline, cubic when thin and later a mixture of cubic and monoclinic $ZrO_2$. In N ammonium borate, only cubic $ZrO_2$ was found. Immersion of a previously formed film or anodization in 100% $H_2SO_4$ or anodization in alkaline glycerol from 40–250°C gave rise to diffuse bands only. The incorporation of ions such as $Na^+$ from the electrolyte appears to be an important factor in determining the rate of anodic growth because such material will greatly affect the resistivity of the films and hence the ease of ion transport through the oxides. (P.C.H.)

**29286** KINETIC STUDY OF THE OXIDATION OF ZIRCONIUM AT HIGH TEMPERATURES. Marcel Perdereau and Jean Bardolle (ENSCP, Paris and Faculté des Sciences, Reims, France). Compt. Rend., 256: 4665-8(May 27, 1963). (In French)

The initial velocities of the oxidation of Zr at high temperatures were studied on three types of Zr: Kroll, Van Arkel and purified Van Arkel. The kinetics were followed on a thermobalance of the MacBain type. The metals were rolled to a thickness of 0.5 mm and samples were heated under vacuum to 800°C in order to assure the recrystallization of the metal before oxidation. The reactions were carried out in purified oxygen. The results show the effects of the metal purity and of the oxygen pressure. In order to define the kinetics and the effects of purity, a comparison was made of the oxidation of the three types of Zr at 700, 800, and 900°C for an $O_2$ pressure of 1 cm Hg and a total reaction time of 200 min. The oxidation curves obtained as a function of time show that the purer the Zr the slower the oxidation. Analysis of the curves shows that the weight increase per surface unit follows a law of the form $(\Delta m/s)^n = kt$, where t is time. The values

of the exponent n and the constant k are tabulated for the different Zr purities. For pure Zr, the oxidation curve is a straight line. The velocity of the oxidation reaction passes through a maximum for an $O_2$ pressure of the order of 1 cm Hg. (J.S.R.)

**29287** KINETICS OF THE OXIDATION OF MAGNESIUM IN DAMP CARBON DIOXIDE AT HIGH TEMPERATURES. Raymond Darras, Jean Paidassi, and Francis Leroy (CEN, Saclay, France). Compt. Rend., 256: 5126-9(June 10, 1963). (In French)

The kinetics of the oxidation of Mg in the presence of damp $CO_2$ was compared with that observed in damp oxygen in the temperature interval from 500 to 600°C. Below 560°C, the much lower oxidation of Mg in the damp $CO_2$ is probably due to a preferential adsorption of the $CO_2$ on the sample surface, inhibiting the reaction of the water vapor with the metal. (tr-auth)

**29288** PROPERTIES OF SURFACE FILMS FORMED DURING THE DRY CORROSION OF IRON AND STEEL BY CARBON DIOXIDE UNDER PRESSURE. P. Bastien and M. Colombie (l'Ecole Centrale, Paris). Corrosion Anti-Corrosion, 11: 169-75(May 1963). (In French)

The oxide layers formed at temperatures between 450 and 620°C and pressures between 1 and 25 kg/cm$^2$ were studied by micrography and x-ray scattering on iron and steel samples. In addition to the classic corrosion, a carburization phenomenon was observed at high pressures. Amorphous carbon was identified in or on the oxide in all the tests. Orientation of the magnetite was also observed. The corrosion by carbon dioxide is very different from the corrosion by air or oxygen, because of the secondary reactions. (tr-auth)

**29289** CONTRIBUTION TO THE STUDY OF THE CORROSION OF NIOBIUM AS FUNCTION OF THE ATMOSPHERE AND OF THE TEMPERATURE. Walter Stuckens and Roger Durand. Corrosion Anti-Corrosion, 11: 180-9(May 1963). (In French)

Recent developments of Nb in the nuclear, electronic, and chemical industries have led to the study of its behavior at high temperature under different atmospheres. The corrosion behavior was determined with a continuous method: thermoponderal analysis. The phases formed were identified by x-ray diffraction, and micrography was used to follow their evolution as a function of time. Temperature (room to 1500°C), atmosphere (oxygen, nitrogen, and $CO_2$), partial pressure, and purity of the metal were the factors varied. The reaction process was studied in each case. Nb is stable up to 400°C in oxidizing atmosphere; above this temperature it is sensitive particularly to air and oxygen. The mechanical properties are radically modified by the diffusion of oxygen and nitrogen into the metal. The initial oxidation step is independent of the temperature and is connected to the grain orientation up to 600°C. Above that temperature the oxidation is controlled by the diffusion of oxygen and of the metal across the oxide layer first formed. (J.S.R.)

**29290** INVESTIGATIONS OF NIOBIUM–ZIRCONIUM OXIDATION PROCESS. D. A. Prokoshkin, E. V. Vasil'eva, and V. Ya. Yankushevich. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 1, 186-90(Jan.-Feb. 1963). (In Russian)

Studies were made of oxidation kinetics in Nb–Zr alloys with 25 to 50 wt % Zr at 1000, 1100, and 1200°C. It is shown that small admixtures of zirconium (0.25 to 15 wt %) reduce Nb resistance to oxidation while higher admixtures (15 wt % and more) improve it. (R.V.J.)

**29291** OXIDATION OF Nb–Zr ALLOYS. D. A. Prokhoshkin, E. V. Vasil'yeva, and V. Y. Yanushkevich. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 1, 186-90(Jan.-Feb. 1963).

The effect of Zr on the oxidation resistance of Nb–Zr alloys containing 0.25, 0.5, 1.5, 10, 15, 20, 25, 30, 40, or 50% Zr was investigated. Alloy specimens were obtained by compacting $ZrI_2$ and 99.78% pure Nb and melting the compacts in an unconsumable-electrode arc furnace in an Ar atmosphere under a pressure of 250 mm Hg. Specimens were oxidized in air at 1000, 1120, and 1200°C for 1, 2, 3, 5, and 10 hrs. Zr at contents of 0.25 to 10% was found to accelerate oxidation; however, a further increase of Zr content up to 50% lowers the oxidation rate continuously. An alloy with 50% Zr oxidizes at a rate of ~10, 18, or 25 mg/cm$^2$ hr at 1000, 1100, or 1200°C, respectively. The oxidation of alloys with 40 and 50% Zr at 1000 and 1100°C follows a nearly parabolic rate, which indicates that the oxide film has a protective ability. At 1200°C the oxidation rate is linear. The scale of alloys with up to 25% Zr is loose and separates from the metal. In an alloy with 50% Zr, the scale adheres tightly to the metal. A thin sub-layer was found under the outer scale layer in all alloys tested. The sub-layer has a higher hardness than the metal and extends to a depth of 0.3 to 1.0 mm, depending on alloy composition. Metallographic and x-ray diffraction examinations showed that the increase of oxidation resistance in alloys containing 40 to 50% Zr is apparently the result of the formation of a new phase, the 6 $ZrO_2 \cdot Nb_2O_5$ compound, which has an orthorhombic structure, and the formation of a subscale. Both slow down the diffusion of oxygen into the metal. (OTS)

**29292** CORROSION PROTECTION OF ALUMINUM. Robert S. Dalrymple and William B. Nelson (to U. S. Atomic Energy Commission). U. S. Patent 3,096,220. July 2, 1963. Filed Oct. 31, 1960.

Treatment of aluminum-base metal surfaces in an autoclave with an aqueous chromic acid solution of 0.5 to 3% by weight and of pH below 2 for 20 to 50 hrs at 160 to 180°C produces an extremely corrosion-resistant aluminum oxide-chromium film on the surface. A chromic acid concentration of 1 to 2% and a pH of about 1 are preferred. (D.C.W.)

## Fabrication

**29293** (APAE-123) TUBE-TO-TUBESHEET WELDING DEVELOPMENT PROGRAMS FOR 30 MEGAWATT PROTOTYPE SODIUM INTERMEDIATE HEAT EXCHANGER AND STEAM GENERATOR. (Alco Products, Inc., Schenectady, N. Y.). [nd]. Contract AT(11-1)-666. 109p.

Special welding techniques for joining Inconel weld overlays on type 316 stainless steel tubesheets and channels are described. The program for the development of the required welding procedures are divided into three specific programs: overlaying Inconel filler Metal 82 on type 316 stainless steel, welding type 316 stainless steel tubes to a type 316 stainless steel tubesheet, and welding Inconel-type 316 stainless steel composite tubes to Inconel weld overlaid type 316 tubesheets. Shock tests are described which attempt to assimulate the most drastic thermal transient that could occur in both units and to evaluate the effect of the resulting stresses on the Inconel overlay and the tube-to-tubesheet welds. (N.W.R.)

**29294** (BMI-1637) FABRICATION OF $UO_2$ FUEL RODS BY VIBRATIONAL COMPACTION AND PRESSURE BONDING. Stanley W. Porembka, Charles B. Boyer (Battelle

Memorial Inst., Columbus, Ohio); and Joseph J. Hauth (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 28, 1963. Contract W-7405-eng-92. 28p.

Over 60 fuel rods having variations in $UO_2$ particle size, micronized $UO_2$ content, cladding material, and cladding thickness were fabricated in an investigation of the combined use of vibrational compaction and gas-pressure-bonding as a possible low-cost method for making uranium dioxide fuel rods. It was found that fuel rods having densities approximately 95% of theoretical with acceptable surface characteristics can be produced with oxide mixtures containing 30 to 40% micronized oxide. Packing densities of approximately 75% of theoretical and for relatively thin-walled cladding a maximum particle size of 20 mesh were also found necessary. Bonding parameters consisted of 3 hr at 1149°C and 10,000 psi. Agglomeration of the micronized $UO_2$ resulted in some fuel nonuniformity and suggests the possible usefulness of swaging as a precompaction operation. The effects of pressure bonding on Types 304, 304L, 347, and 318 stainless steels were also investigated with respect to final grain size. Prior cold work permitted limited control of grain size on these steels. Huey tests indicated that little sensitization of Types 347 and 304L alloys can be expected under the bonding condition employed. (auth)

**29295** (BRB-60) WARM EXTRUSION OF NATURAL URANIUM TUBING. P. W. Miller and L. Lewis (Bridgeport Brass Co., Conn.). Feb. 6, 1961. Contract AT(30-1)-1405. 26p.

The warm extrusion of uranium tubing showed enough potential to warrant further development. A strict control of grain structure, tubular dimensions, and surface quality was exercised. Potential irradiation stability, as measured by the growth index G3 was positive, indicating possible elongation. An estimate of billet to good slug yield based on 100% acceptance, revealed a value of approximately 79.5%. The overall results compared favorably with existing extrusion techniques for uranium. (auth)

**29296** (PB-181458) ELECTRON-BEAM WELDING—ITS INDUSTRIAL POTENTIAL. An Evaluation of Commercial Applications. R. E. Greenlee and W. A. Losoncy, Jr. (Williams (Clyde) and Co., Columbus, Ohio). [1962]. Contract CC 4757. 21p.

A review is presented of the advantages of electron-beam welding in industrial joining processes. The applications that have been made and some of the industrial research and development efforts are described in some detail. The principles and equipment of electron-beam welding are discussed briefly. A bibliography of 57 references is included. (D.L.C.)

**29297** (TID-18956) WELDING THIN WALLED TITANIUM PRESSURE VESSELS. G. Pagnotta and G. Hume (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract [W-31-109-eng-52]. 7p.

A discussion is given of the more important variables of the welding schedule and proper design of jigging to facilitate welding thin-walled titanium by the tungsten-inert gas process. Tensile specimens, bend tests, x rays, and metallography showed the process to be capable of meeting the criteria established for this application. (auth)

**29298** (UNC-5055) CARBIDE FUEL DEVELOPMENT. Phase IV Report, September 15, 1961–September 30, 1962. A. Strasser (United Nuclear Corp. Development Div., White Plains, N. Y.); K. Taylor, and J. Anderson (Carborundum Co., Niagara Falls, N. Y.). Mar. 31, 1963. Contract AT(30-1)-2899. 61p.

FUEL FABRICATION AND CHARACTERIZATION. Single-phase solid solution UC–PuC powders were prepared by the carbon reduction of a mixture of $UO_2$ and $PuO_2$. A simple method was developed to determine the completion of the reaction by analyzing the exhaust gas from the furnace for CO. Four groups of solid solution $(U_{0.8}Pu_{0.2})C_{0.95}$ pellets were prepared for irradiation tests. The groups differed in the enrichment of uranium and in the presence or absence of nickel sintering aid. Without sintering aid, densities averaged about 92% of theoretical; with sintering aid the average density was about 96% of theoretical. The second phase, promoted by the use of nickel sintering aid, was identified as sesquicarbide. IRRADIATION TESTS. The post-irradiation examination of UC specimens irradiated to 16,400 Mwd/tonne (avg) at 1400°F and 9.6 kw/ft was completed. The effect of radiation on UC was slight: 0.001 in. diametral increase, 0.4% fission gas release, and no microstructural changes. The $(U_{0.8}Pu_{0.2})C_{0.95}$ irradiation tests were redesigned for insertion in GETR. All the irradiation specimens were assembled, and assembly of the capsules was started. One fueled and one dummy capsule were shipped to the test site. (auth)

**29299** (AEC-tr-5884) THE TEMPERATURE DISTRIBUTION IN A ROD DURING CONTACTLESS ZONE RECRYSTALLIZATION. I. V. Milov, V. V. Okinshevich, and D. M. Skorov. Translated for Ames Lab., Ames, Iowa from Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Toplivo, No. 2, 56-62(1962). 11p.

A method of studying the temperature distribution in a rod during contactless zone recrystallization is proposed. A method of calculating the heat flux required to create a narrow fused zone is given in the case of contactless zone recrystallization. The shape of the boundaries of the fused zone is considered for different focusing of the heat flux supplied to the zone. (auth)

**29300** (EURAEC-399) EXTRUSION OF $UO_2$ ENRICHED TO 5.5% FOR IRRADIATION TEST IN VBWR REACTOR OF VALLECITOS—DRAFT OF FINAL REPORT. J. Mercier (Compagnie Industrielle des Combustibles Atomiques Frittes, Corbeville, par Orsay (Seine-et-Oise), France). [1962]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 075-61-11-RDF. 17p. A translation.

Activities in a program to compare the behavior of extruded and sintered $UO_2$ with $UO_2$ formed by pressing and sintering are reported. Discussions are included concerning raw material study results, orientation tests to determine extrusion and sintering parameters, and rod fabrication and canning. Results show that size precision higher than 0.01 mm, average density of 10.70 g/cm$^3$, and impurities of <1500 ppm Fe and other elements can be attained. (J.R.D.)

**29301** THE WELDING AND BRAZING OF THE REFRACTORY METALS NIOBIUM, TANTALUM, MOLYBDENUM AND TUNGSTEN—A REVIEW. M. H. Scott and P. M. Knowlson (British Welding Research Assoc., Cambridge, Eng.). J. Less-Common Metals, 5: 205-44 (June 1963).

This review covers the present and future problems in the development and welding of niobium, tantalum, molybdenum, and tungsten and their alloys. Their metallurgical characteristics are discussed together with the influence of impurities and alloying elements on mechanical properties, alloy development, and weldability. Other factors briefly discussed are availability, high-temperature strength, ductility, and oxidation resistance. The general

problems which will be met when welding these materials are described together with means of assessing weld quality. Information on the welding and brazing of each material and its alloys is assessed in order to define lines of research. Most reported work has been carried out in the United States and the outline research program is drawn up as a basis for work in the United Kingdom. It is felt that a welding research program must be included as an integral part of the development of refractory metal alloys. (auth)

**29302** PREPARATION AND FABRICATION OF URANIUM–CARBON ALLOYS. A. Accary (CEN, Saclay, France). J. Nucl. Mater., 8: 281-306(May 1963). (In French)

A critical review is presented of the different methods of preparing and forming uranium–carbon alloys relevant to their use as fuel materials. The numerous methods are classified on a systematic basis, and attention is drawn to the advantages and drawbacks of each. Micrographs are presented of the various uranium–carbon alloys according to their composition, mode of preparation, and subsequent treatment. In conclusion, the problems of using the methods described on an industrial scale are posed. (auth)

**29303** INTERNAL STRESSES IN THE MANUFACTURE OF NUCLEAR REACTOR PRESSURE VESSELS. Ivan Kupka, Jaroslav Němec, and Stanislav Štěpánek. Jaderna Energie, 9: 146-55(1963). (In Czech)

The importance of the influence of internal (inherent) stresses on the operation ability and on manufacture of large reactor pressure vessels is reported. Methods of measurement of internal stresses in the vessel wall are enumerated and the most convenient method is indicated for given purpose. Further the results of internal stresses measurements in welded rings of a cylindrical wall of a reactor vessel using hand and electroslag welding methods are reported. Experimental results of internal stress investigation are analysed and compared with theoretical calculations. Calculation difficulties and the necessity of evaluation of internal stresses-limiting values for larger vessels with their danger of brittle failures in welding joints, are indicated as well. (auth)

**29304** MANUFACTURE OF BERYLLIUM TUBES. Joseph Clifford Guest and William Arthur Sallis (to T. I. (Group Services) Ltd.). British Patent 922,143. Mar. 27, 1963. Filed Feb. 27, 1961.

An improvement to a method of manufacturing Be tubes is patented. The method includes producing a hollow Be billet by casting, hot pressing, or sintering Be powder; placing an extensible metal core in the bore of the billet and the billet in an extensible metal envelope; heating the billet, core, and envelope to 900 to 1100°C; extending and reducing the assembly to the desired diameter; and removing the core and envelope. The improvement consists of forming the core from a material having a higher coefficient of expansion than that of Be. The core may be tubular or have a tubular part and a solid part. (M.P.G.)

**29305** IMPROVEMENTS IN OR RELATING TO CERAMIC FUELS FOR NUCLEAR REACTORS. Ronald George Sowden (to United Kingdom Atomic Energy Authority). British Patent 924,939. May 1, 1963. Filed Sept. 5, 1960.

A process for the production of ceramic fuel material enriched with Pu is patented. A Pu compound, such as plutonyl dinitrate, is dissolved in an organic solvent. The preferred solvent is methyl isobutyl ketone (hexone). The solution is mixed with an organic polymer, which is suitable as a binding agent, and the mixture is added to powdered uranium dioxide, then compacted and sintered. Polybutyl methacrylate may be used as the binding agent, but polyvinyl esters and other polymethacrylate esters may be used. The binding agent may be plasticized with glycerol or dibutyl-phthalate, and the solvent for the binding agent is preferably hexone. The process has the advantage of adding the Pu to the U at the last practicable moment, thus avoiding the special techniques required for handling Pu. (M.P.G.)

**29306** IMPROVEMENTS IN OR RELATING TO FUEL ELEMENT FABRICATION. Henry Lloyd and Alexander McLean-Elrick (to United Kingdom Atomic Energy Authority). British Patent 925,226. May 1, 1963. Filed Oct. 24, 1960.

A method of loading ceramic pellets into a tubular metal can is patented. The can has smaller cross-sectional dimensions than the pellets to provide a tight fit between the pellets and the can at ambient temperatures. The can is surrounded by a high-frequency induction-heating coil, which heats the can to a temperature at which the pellets can be inserted. The can and a magazine containing the pellets are connected and evacuated, and when the can reaches the proper temperature, a push rod pushes the pellets out of the magazine into the bore of the can. The method may be used for loading ceramic fuel pellets into a reactor fuel-element can. (M.P.G.)

**29307** IMPROVEMENTS IN AND RELATING TO THE FABRICATION OF NUCLEAR REACTOR ELEMENTS. (to Babcock and Wilcox Co.). British Patent 926,136. May 15, 1963. Priority date May 27, 1958, United States.

A method of fabricating a reactor fuel element composed of $UO_2$ enclosed by a sheath is patented. A tube of sheath material such as stainless steel shorter than the desired length and with a cross-sectional area greater than that desired is closed at one end and filled with the desired mass of $UO_2$ in powder or granular form. Using vibration and applying a downward force, the $UO_2$ is compacted to a density of from 7.0 to 7.2 g/cm$^3$, and the other end of the tube is closed. The closed container is worked by rotary swaging to increase the length and reduce the cross-sectional area to the desired values, thereby increasing the density of the $UO_2$ within the container. Densities of 9.4 g/cm$^3$ or greater can be obtained. Various types of end closures for the sheath are described. (M.P.G.)

**29308** METHOD OF PRODUCING A DIFFUSION RESISTANT BOND BETWEEN URANIUM AND ALUMINUM. (to Atomic Energy of Canada Ltd.). British Patent 927,159. May 29, 1963. Priority date Mar. 28, 1961, United States.

A method of securely bonding Al to U by coating the surface of the U with a thin layer of uranium oxide is patented. The oxide layer can be formed by heating the U in air or electrolytically by anodizing the U in an aqueous solution of NaOH. The Al is extruded onto the oxide surface under pressure at high temperatures. The oxide layer provides a good diffusion barrier and does not have a high neutron-absorption cross section. (M.P.G.)

**29309** FISSIONABLE FUEL CAPSULES AND METHOD OF MANUFACTURING SAME. Harold N. Barr and Louis Frank (to Martin-Marietta Corp.). U. S. Patent 3,091,581. May 28, 1963. Filed Mar. 3, 1958.

A reactor fuel element, which is characterized by a consistently excellent bond between clad and core, is patented. The cermet core of the fuel element consists of particles of an oxide of a fissionable metal uniformly dispersed and embedded in a continuous matrix of Al, Zr, Mo, zirconium

carbide, or molybdenum disilicide. The core is encased in a seamless envelope of the same material as the matrix, and the envelope is metallurgically bonded to the core. The fuel element may have various shapes, such as rod, tube, sphere, plate, or disk. (M.P.G.)

**29310** METHOD OF PRODUCING CANNED FUEL RODS FOR NUCLEAR REACTORS. Stefan George Bauer (to Rolls-Royce Ltd.). U. S. Patent 3,096,264. July 2, 1963. Priority date Dec. 10, 1958, Great Britain.

Canned fuel rods can be produced by bending a strip of metal into a tubular form with the longitudinal edges adjacent and outwardly flanged, twisting the tubular part about its longitudinal axis to give the flanged edges a helical form, and welding the flanges together to form a tube with an external helical rib formed by the joined flanges. The fuel, in pellet form, is placed in the tubular form before or after the twisting and welding; and the ends are plugged. (D.C.W.)

**29311** METHODS OF MANUFACTURING MICROPOROUS METALLIC MEMBRANES. Roger Lacroix (to Commisariat a l'Energie Atomique). U. S. Patent 3,097,149. July 9, 1963. Priority date Aug. 18, 1959, France.

Microporous metallic membranes with pores less than 0.05$\mu$ can be produced by forming an alloy of the desired metal and a metal distinctly more unstable than the desired metal. The unstable metal is then removed by subjecting its ions to an extraction potential by either a purely chemical (selective attack) process or by an electrolytic process. (D.C.W.)

## Properties and Structure

*Refer also to abstract 28837.*

**29312** (ASD-TDR-62-594(Pt.II)) INVESTIGATION OF TANTALUM AND ITS ALLOYS. Frank F. Schmidt, Edwin S. Bartlett, and Horace R. Ogden (Battelle Memorial Inst., Columbus, Ohio). Mar. 1963. Contract AF33(657)-7927. 128p. (AD-406757)

Minor (1 to 2%) reactive metal (Zr, Hf) additions to Ta–W–Mo alloys effect pronounced strengthening at 1925°C with minimal degradation of low-temperature alloy behavior. Additions of carbon to alloys containing reactive metals degrade both 1925°C strength and low-temperature behavior; however, ZrC dispersions exhibit pronounced strengthening at lower temperatures (1480°C). Solution-process anneals for alloys containing ZrC dispersion greatly increase strength at 1480°C, but seriously impair fabricability and ductility. Molybdenum is a less effective strengthener than tungsten as an alloying addition to tantalum. Tungsten additions provide higher stress-rupture strengths with less degrading effects on low-temperature ductility than do equivalent atomic percentages of molybdenum. Welding increases the ductile-to-brittle transition temperature of Ta–W–Mo alloys by 300 to 500°C. Rhenium and ruthenium additions showed little or no superiority to tungsten as solid-solution strengtheners, when both high- and low-temperature effects were considered. (auth)

**29313** (BBC-118) RESEARCH ON MODIFIED BERYLLIDES AS HIGH-TEMPERATURE NUCLEAR MATERIALS. Quarterly Progress Report, December 1, 1962 through February 28, 1963. R. M. Paine, A. J. Stonehouse, and W. W. Beaver (Brush Beryllium Co., Cleveland). Mar. 31, 1963. Contract AT(33-3)-20. 15p.

The solubility of aluminum in both $ZrBe_{13}$ and $Zr_2Be_{17}$ is determined at room temperature, 1500, 2000, and 2500°F. The solubility studies involving nickel in these two beryllides is not quite complete, owing to the extensive solubility of nickel encountered. The significance of the solubility data is discussed, and it is shown that approximately 0.30 wt % Al over that which is soluble at intermediate temperatures is required to provide oxidation resistance in $ZrBe_{13}$ and $Zr_2Be_{17}$. (auth)

**29314** (BMI-X-238) PROGRESS ON USAEC/AECL COOPERATIVE PROGRAM. Quarterly Report, March 1963–May 1963. Stanley W. Porembka (Battelle Memorial Inst., Columbus, Ohio). June 10, 1963. Contract W-7405-eng-92. 18p.

Long-term creep-rupture properties of three sintered-aluminum-powder alloys (SAP-895, M-257, and M-583) are reported along with completed results of short-term tests. Long-term creep-rupture properties of Zircaloy-2 are also given. The specimens representing Zircaloy-2 in both annealed and 15% cold-worked conditions had accumulated test times ranging from 14,500 to 48,500 hr prior to inclusion in the present program. (N.W.R.)

**29315** (CERN-63-11) LA RECHERCHE DE MARTENSITE. (The Examination of Martensite). A. H. Achermann (European Organization for Nuclear Research, Geneva). Apr. 9, 1963. 14p.

A study of the structure of stainless steels made with an electron microscope with secondary electron emission under ion bombardment, the metioscope, is reported. With this microscope the martensitic transformation of austenitic stainless steels can be examined. The samples are quenched in liquid hydrogen. Photomicrographs of the study of AISI 304 steel are reproduced to show the results that can be obtained with the metioscope. A cross section of the metioscope is given. (J.S.R.)

**29316** (DMIC-182) STRUCTURAL CONSIDERATIONS IN DEVELOPING REFRACTORY METAL ALLOYS. R. I. Jaffee and G. T. Hahn (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 31, 1963. Contract AF33(616)-7747. 29p.

Progress made in applying advanced techniques and structural concepts to the problem of strengthening the Group VI-A metals, Cr, Mo, and W, is examined. At low temperatures, $T/T_m < 0.2$, dislocations and grain boundaries play an important role. High strength values and the marked temperature and strain-rate dependence of the yield stress exhibited by the Group VI-A metals in this range are consistent with the idea that dislocation movement is rate controlling and thermally activated. Dislocation-mobility considerations also point to the existence of high stresses in advance of a moving crack, and, consequently, a low level of crack-propagation resistance. A second factor contributing to the brittleness of the Group VI-A metals is grain-boundary weakness caused by interstitial-atom impurities. Studies of rhenium additions to the Group VI-A metals suggest that the brittleness tendency can be inhibited by alloying. There is evidence that alloying with rhenium influences dissolved interstitial atoms, changes the morphology of dislocations and grain-boundary oxides, promotes twinning, and affects the density of states at the Fermi level. At intermediate temperatures, $0.2 < T/T_m < 0.4$, dislocation-interstitial atom impurity interactions contribute to strengthening. At high temperatures, $T/T_m > 0.4$, stable dispersions of fine particles are potent strengtheners of the Group VI-A. Small nonmetallic additions, i.e., dope, acting in solution or possibly at the grain boundaries may also contribute to the stability of non-sag tungsten filaments. (auth)

**29317** (EUR-272.f) AMÉLIORATIONS DE LA TECHNOLOGIE DU SAP EN VUE DES APPLICATIONS NUCLÉAIRES— PROPRIÉTÉS DES MATÉRIAUX ETUDIES. (Improvements in Sap Technology with a View to Nuclear Applications— Properties of the Materials Studied). P. Gualandi (Istituto Sperimentale Metalli Leggeri, Novara, Italy) and P. Jehenson (European Atomic Energy Community). 1963. 31p.

Experimental work in the initial stage of a long range research program on SAP, in the field of the ORGEL project, is described. The principal improvement on the semi-finished products was obtained by a degassing thermal treatment under vacuum (about twenty hours at 600 to 625°C, under $10^{-4}$ to $10^{-5}$ mm Hg) of the powders after cold compaction. The main consequences of this special treatment on SAP are following ones: an important decrease of the residual gas content, which becomes lower than 10 ppm, and consequently, an excellent high temperature (600°C) stability and a considerable improvement of the welding properties. Some important characteristics of the four SAP grades, mechanical properties at room and at high temperature, fatigue and creep resistance, pressure tests, and hot stability are given along with the actual tolerances obtained in the fabrication of fuel element and pressure tubes. A very large dispersion of the results must probably be attributed to the nonhomogeneity of the powders. (auth)

**29318** (GA-3559) TECHNIQUES AND PROCEDURES FOR EVALUATING LOW-PERMEABILITY GRAPHITE PROPERTIES FOR REACTOR APPLICATION. K. Worth (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Mar. 1, 1963. Contract AT(04-3)-314. 39p.

The equipment, techniques, and procedures used for the measurement of some of the physical, mechanical, and thermal properties of low-permeability graphite are described. The graphite materials tested are intended for application in fuel elements for the High-temperature Gas-cooled Reactor (HTGR). The properties measured include permeability, tensile and shear strengths, moduli of rupture and elasticity, thermal conductivity, and thermal expansion. Test apparatuses with various measuring and recording devices for measurement of these properties are described, and their advantages and limitations are pointed out. Results obtained from testing some of the low-permeability graphites are listed for illustrative purposes only. (auth)

**29319** (GEAP-3880(Pt.II)) COMPARATIVE STUDY OF PuC–UC AND $PuO_2$–$UO_2$ AS FAST REACTOR FUEL. PART II. ECONOMIC CONSIDERATIONS. G. D. Collins (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Nov. 15, 1962. Contract AT(04-3)-189. 36p.

The Fast Ceramic Reactor is a fast reactor system using recycled plutonium fuel with both axial and radial blankets of depleted uranium. The relative merits of two ceramic fuel systems that might be used–one based on mixed oxides of plutonium and uranium and one based on mixed carbides–are examined. The fuel cycle costs are compared, particularly with respect to fabrication and reprocessing unit costs. Two separate cases for carbide fuel are considered, each of which exploits the superior thermal conductivity and higher fuel density of carbide in a different way. (auth)

**29320** (GEMP-23A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT No. 23, PART A. (General Electric Co. Advanced Technology Services, Cincinnati). May 31, 1963. Contract AT(40-1)-2847. 37p.

Stress-rupture tests comparing sintered and arc-cast molybdenum at 2200°C furnished additional evidence that the Mo–A material is a powder-metallurgy-sintered product and that Mo–B and Mo–C are arc-cast materials. The stress-rupture life and ductility of arc-cast molybdenum were found to be similar, whereas the sintered material differs from the arc-cast material and its strength and creep characteristics are dependent on the source. The sintered molybdenum is susceptible to contamination by trace impurities in an inert atmosphere. By comparison, the arc-cast material was extremely clean. The stress-rupture and creep testing of tungsten was initiated. Tests were performed at 1600 to 2800°C for rupture times to 12 hours. The test results indicate that the strength and creep characteristics of the material are dependent on the source. The stress-rupture testing of tantalum was continued with the emphasis on the effect of contaminants in the test atmosphere. As expected, the stress-rupture tests confirmed that this material is much more susceptible to contamination at temperatures of 2400 to 2600°C than the other refractory materials tested. Consistent results were obtained in an argon atmosphere using a tantalum foil around the specimen. Prior tests without this protective foil produced unusually scattered results. The preliminary screening of brazing alloys for tantalum was completed. The major evaluation was performed on braze alloys from the Nb–Ta–V ternary system. The advantages of alloys from this system are: suitable for brazing temperatures between 1950 and 2400°C; no intermediate phases are present in the alloys or in the diffusion products formed by the alloys; erosion of the base metal from the liquid braze alloys is considered minimal for this time exposure, ranging from 0 to 0.005 inch during the braze cycle; increase in remelt temperature of the braze joint by diffusion is comparatively rapid; and the alloys can be applied to the braze joint by standard sheet, wire, and powder techniques. Effects of radiation of high-temperature alloys. Two creep-rupture test stands used in the high-temperature alloy program were modified and are now being used to test the refractory metals in a hydrogen atmosphere. Two creep-rupture stands remain at Ge-ITS and will be used for testing the control and irradiated high-temperature alloy specimens. Tungsten specimens were irradiated in the Oak Ridge Research Reactor at reactor ambient temperatures. A set of 116 tungsten wires was also irradiated. Tungsten creep-rupture control specimens were tested at 1100 to 1400°C. Irradiated creep-rupture specimens were tested at the same temperatures. Creep-rupture testing of control specimens containing trace quantities of boron were initiated at GE-ITS. Capsule 33MT-99 containing the irradiated, boron-containing specimens was removed from the ETR following a two-cycle irradiation. A satisfactory standard procedure for preparing irradiated and control René 41 specimens for electron micrography was developed, and the structure evaluation of this material was resumed. (auth)

**29321** (HW-61379) RUPTURE KINETICS OF ZIRCALOY CLAD FUEL ELEMENTS IN HIGH TEMPERATURE WATER AND STEAM. CO-EXTRUDED ROD ELEMENTS WITH PINHOLE DEFECTS. Interim Report No. 2. V. H. Troutner (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 3, 1959. Contract AT(45-1)-1350. 5p.

Laboratory measurements of fuel element rupture kinetics in high-temperature water and steam are presented for co-extruded Zircaloy-2-clad uranium rods with pinhole defects. Rupture curves are shown for various

heat treatments and for a uranium–zirconium alloy. (N.W.R.)

**29322** (HW-74677) FATIGUE TESTING OF UNALLOYED PLUTONIUM. H. R. Gardner (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Sept. 25, 1962]. Contract AT(45-1)-1350. 9p.

A pneumatic apparatus was developed for room-temperature high-speed fatigue testing at a frequency of 270 cps. The apparatus is based on the principle used to vibrate the reeds in a harmonica, and a recording of frequency vs. time is used to indicate failure. Test results are given for as-cast Pu, and its fatigue limit appears to be ~14,000 psi or ~20% of the ultimate tensile strength. Fatigue crack propagation is discussed. (D.L.C.)

**29323** (HR-63-264) MICROSTRUCTURE AND MECHANICAL PROPERTIES OF CERAMICS. Technical Report No. 19. R. J. Stokes (Honeywell Research Center, Hopkins, Minn.). May 1963. Contract Nonr-4076(00). 75p.

The influence of microstructure on the following aspects of mechanical behavior was considered: elastic deformation; anelastic behavior; plastic deformation; brittle fracture; high-temperature deformation; and creep. In addition to familiar variables such as grain size and the presence and distribution of porosity or a second phase, the term microstructure was considered broadly enough to allow discussion of the role that fundamental variables such as crystal structure, bond character and crystalline defects, impurities, vacancies, and dislocations play in determining mechanical behavior. (auth)

**29324** (KR-48) THE SYSTEM $UO_{2+x} + Y_2O_3 + O_2$ AND INTERPRETATION OF THE DEFECT STRUCTURE IN $UO_{2+x}$. Kjell Hagemark (Norway. Institutt for Atomenergi, Kjeller). June 1963. 25p.

By the use of a thermogravimetric method, equilibrium values of the partial pressure of oxygen over uranium oxide with and without additions of yttria were determined. The defect structure in $UO_{2+x}$ is discussed. (N.W.R.)

**29325** (LA-2871) CRITICAL STRAIN IN HIGH PURITY TANTALUM AND TANTALUM–TUNGSTEN ALLOYS. D. J. Murphy, W. E. Ferguson, and G. S. Hanks (Los Alamos Scientific Lab., N. Mex.). Sept. 10, 1962. Contract W-7405-eng-36. 24p.

The response to deformation and annealing of high-purity tantalum and tantalum alloys containing 0.1 or 3.0 wt % tungsten was investigated. Particularly, values of critical strain and characteristics of subsequent growth of coarse grains were correlated with hardness changes in these alloys. A critical strain in high-purity tantalum corresponding to a reduction by rolling of 18% was found to be lowered to 13% by a 0.1 wt % W addition and to 9.5% by a 3.0 wt % W addition. Tungsten additions accentuated the response of tantalum to work hardening, increased its annealed hardness, and retarded the rate of growth and final size of coarse grains formed under critical strain conditions. (auth)

**29326** (TID-17133) THERMAL BEHAVIOR OF HYDROGEN-BONDED GLASSES. J. A. McMillan (Argonne National Lab., Ill.). Aug. 1962. Contract W-31-109-eng-38. 26p. (UAC-6775)

The ability to produce vitreous states of aggregation of typical hydrogen-bonded compounds such as oxygen and nitrogen hydrides, alcohols, and amines is investigated by studying the warm-up behavior of glasses of pure compounds and binary mixtures. Those compounds that crystallize during warm-up do so at a reproducible temperature due to their large activation energies of nucleation. There are other transformations that occur at reproducible temperatures, namely, changes in specific heat and glass stabilization processes. The low-temperature stability of these glasses is interpreted in terms of a network of hydrogen bonds according to the well-known Zachariasen rules of glass formation. Incorporation of the crystallization temperature to the temperature-composition phase diagrams of binary mixtures shows that the difficulty of crystallizing mixtures of compounds that crystallize in the pure state is due to an increased nucleation activation energy due to the mixing. Finally, a correlation is found between the temperatures at which these processes occur and the temperatures at which radiation-damage annealing takes place. (auth)

**29327** (TID-18998) METALLOGRAPHY OF URANIUM CONTAINING SMALL ADDITIONS OF IRON, SILICON, OR ALUMINUM. C. L. Angerman and M. R. Louthan, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). May 1963. Contract AT(07-2)-1. 13p.

In uranium with alloying additions of up to 400 ppm Fe and up to 800 ppm of either Si or Al, the various U-containing phases were examined with the electron microscope. These phases were also extracted chemically and identified by electron diffraction. During γ-phase heat treatments, the alloying additions, as well as impurity atoms, segregate into networks of "incipient" precipitates that can be seen only after certain etching treatments. (auth)

**29328** (TID-19007) THERMODYNAMIC AND OTHER ASPECTS OF METALLIC SYSTEMS. Progress Report, June 1962 to June 1963. (Massachusetts Inst. of Tech., Cambridge. Div. of Sponsored Research). Contract AT (30-1)-1002. 8p.

Topics covered are the effects of deformation and annealing on various properties of metals and the thermodynamics of metallic systems. Information is presented on the effects of shock waves on the ordered and disordered alloy $Cu_3Au$, the annealing kinetics of a gold–silver alloy deformed by explosive loading, the deformation of gold at 78°K, the annealing kinetics of gold deformed at and below room temperature, the annealing kinetics of a gold–silver alloy deformed at and below room temperature, the evolution of energy from metals deformed in compression, thermodynamic properties of amorphous and hexagonal selenium and selenium–bismuth alloys, and the heats of formation of five alloys near the composition AgMg. (N.W.R.)

**29329** (UCRL-10755) THE INFLUENCE OF TENSILE STRESS ON GASEOUS PERMEATION IN GLASSY-STATE AND COMPLEX CERAMICS (thesis). Orlin M. Stansfield (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 2, 1963. Contract W-7405-eng-48. 75p.

The influence of static and dynamic uniaxial tensile stress on the steady-state permeation of helium through multiphase, polycrystalline ceramics and fused silica was investigated. Tests on alumina, mullite, and pure fused silica were conducted at temperatures between 25 and 1000°C and at tensile stress levels of 0 to 12000 psi. A mass spectrometer was used to detect helium permeation. No permeation through alumina was detected. Gaseous permeation through mullite specimens of two different microstructures and fused silica specimens was detected and appeared to be an activated process. An increase in the gaseous permeation rate on the order of 1% upon appli-

cation of a tensile stress of 4000 to 5000 psi was found, and was apparently due to a decrease in the activation energy of helium diffusion through the glassy phase. The introduction of gas-conducting channels, such as cracks and separated phase boundaries, through induced tensile stress was not detected. The temperature dependence of Young's modulus of the glassy phase influenced the measured stress effect: a decrease in the modulus at high temperatures enhanced the effect of stress on permeation rate. Closed pores and crystalline phases seemed to influence the absolute magnitude of the stressed and unstressed permeation rate. (auth)

**29330** (UNC-5056) CARBIDE FUEL DEVELOPMENT. Progress Report, October 1, 1962–March 31, 1963. A. Strasser, D. Stahl (United Nuclear Corp. Development Div., White Plains, N. Y.); K. Taylor, and J. Anderson (Carborundum Co., Niagara Falls, N. Y.). May 1, 1963. Contract AT(30-1)-2899. 47p.

FUEL FABRICATION AND EVALUATION. The synthesis and fabrication of $(U_{0.95}Pu_{0.05})C_{0.98}$ test specimens by cold pressing and sintering for out-of-pile property measurements were completed. Theoretical densities of 91% (avg) were obtained without sintering aid and 96% (avg) with 0.1 wt % nickel sintering aid. Mixed sesquicarbide, $(U_{0.8}Pu_{0.2})_2C_3$, was synthesized and fabricated into pellets 94% of theoretical density. Massive, carbon-stabilized PuO was synthesized by the carbon reduction of the dioxide. The carbon content of the product was 0.14 wt %. The coefficients of expansion of $(U_{0.95}Pu_{0.05})C_{0.98}$ with and without nickel sintering aid were measured to 1400°C, and found to be 12.2 to 12.6 × $10^{-6}$/°C. Measurements of melting point and vapor pressure of mixed monocarbides were started by testing standards. Compatibility tests at 593 and 816°C were started. Examination of results to date show a reaction between $(U_{0.95}Pu_{0.05})C_{0.98}$ and Zircaloy-2, and no reaction with type 316 stainless steel and niobium after 1000 hr at 816°C. This is similar to previous results with UC. IRRADIATION TESTS. The assembly of all the irradiation capsules was completed. Ten of the 12 planned specimens of $(U_{0.8}Pu_{0.2})C_{0.95}$ are currently operating in the GETR. The longest burnup obtained to date is 13,000 Mwd/ton (avg). (auth)

**29331** (AEC-tr-5872) THE THERMAL CONDUCTIVITY OF REFRACTORY OXIDES. I. I. Vishnevskii. Translated from Sb. Nauchn. Tr., Ukr. Nauchn.-Issled. Inst. Ogneuporov, No. 3, 274-81(1960). 9p.

An attempted systematization of the problems of thermal conductivity theory is presented in order to shed light on some general patterns of relations for refractory oxides. Some theoretical knowledge of temperature dependence of thermal conductivity and the effect of atomic weight are elaborated. (N.W.R.)

**29332** (AEC-tr-5879) EFFECT OF PRECIPITATION ON THE MECHANICAL PROPERTIES OF A HARDENED Al–Si ALLOY. H. Boehm. Translated by Lydia Venters (Argonne National Lab., Ill.) from Acta Met., 11: 475-84 (1963). 17p.

In precipitation of silicon from a supersaturated Al–Si solid solution the number of silicon nuclei depends strongly on the thermal history of the specimens. Through variation of the quenching conditions it is possible to vary the number of precipitates by several orders of magnitude. The yield strength and the work-hardening of an aluminum alloy with 1.2 wt % silicon exhibit a strong dependence on the number of precipitates. Therefore it is possible to bring about changes of $\sigma_{0.2}$ at a constant extent of precipitation and at equal aging temperature to all values between 4 and 18 kg/mm$^2$ through altering the quenching conditions. In the region of small deformations (less than 0.5%) the work-hardening increases linearly with the yield point. At deformations above 0.5% the work-hardening is independent of the precipitation conditions. Deformation before aging leads to an acceleration of the precipitation in all cases, however the influence on the mechanical properties is dependent on the quenching conditions after homogenization. The results are discussed and compared with theories of the yield point and the work-hardening of precipitation hardened alloys. The observed dependence of the yield point agrees well with the theory of Orowan. (auth)

**29333** (NP-tr-1032) THE STRUCTURE OF THIN METAL FILMS EVAPORATED ONTO ROCK SALT. L. Brueck. Translated by W. Bleyberg (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Ann. Physik, 26: 233-57(1936). 43p.

Thin metal films (Ag, Au, Al, Cu, Co, Pd, Ni, Fe, and Cr) were prepared in a vacuum by deposition as vapor onto rock salt cleavage planes, and their structure was investigated by transmitted or reflected radiation. Above a given temperature of the support characteristic for each of the metals, Au, Ag, Al, Ni, Cu, and Pd, the film obtained on deposition by evaporation consists of a crystal structure which is composed of many small crystallites in mosaic form, which all have the same orientation so as to produce the diffraction pattern of a single crystal. The Co, Fe, and Cr films had not yet obtained a perfect single crystal structure at 540°C, the highest temperature which could be applied. Three orientations occurred simultaneously with Fe and Cr, the orientation increasing at higher temperatures where the (001) plane was parallel with the rock salt surface. The cubes of the face-centered cubic metals were aligned in orientation with the support, whereas the body-centered cubic metals grew on the plane of contact turned about 45° in relation to the rock salt cube. Further experiments showed that the temperature above which single crystals were formed depends on the metal evaporated onto it as well as on the support. An account is given of some further investigations on a novel interference phenomenon already reported by Kirchner and Lassen. (N.W.R.)

**29334** COMMENTS ON THE CRYSTAL STRUCTURES OF $Ba_2Mg_{17}$ AND $Sr_2Mg_{17}$. Frederick E. Wang, Frank A. Kanda, Charles F. Miskell, and Aden J. King (Syracuse Univ., N. Y.). Acta Cryst., 16: 697-9(July 10, 1963). (In English)

The structure of $Sr_2Mg_{17}$ was found to be isomorphous with that of $Th_2Ni_{17}$ and is a derivative structure of $CaZn_5$. It was found that $Ba_2Mg_{17}$ dissolves Mg substitutionally in its lattice. The substitution occurs only on the superlattice (here the $CaZn_5$ type lattice is considered to be the sublattice) and moreover only in a short range order. $Ba_2Mg_{17}$ shows 6/mmm diffraction symmetry for both the sub- and super lattice. It was confirmed to be a derivative of a CaZn type structure but is not disordered and the $c_0$ axis dimension is 15.52 Å. (P.C.H.)

**29335** LANTHANIDE–COPPER INTERMETALLIC COMPOUNDS HAVING THE $CeCu_2$ AND $AlB_2$ STRUCTURES. A. R. Storm and K. E. Benson (Bell Telephone Labs., Inc., Murray Hill, N. J.). Acta Cryst., 16: 701-2 (July 10, 1963). (In English)

Twelve rare earth–copper intermetallic compounds ($XCu_2$, X = rare earth metal) were prepared. Powder x-ray data showed that all of the alloys, as well as $YCu_2$ are orthorhombic and isostructural with $CeCu_2$. $LaCu_2$

was found to have the hexagonal $AlB_2$ structure, and therefore, belongs to the group $P_6/mmm$ ($D^1_{6h}$) with La in positions a:000; and Cu in positions 2d: ($\pm^1/_3$, $^2/_3$, $^1/_2$). Computed and observed relative intensities and interplanar spacings are tabulated. (P.C.H.)

**29336** DISLOCATIONS IN DEFORMED AND ANNEALED NIOBIUM SINGLE CRYSTALS. J. O. Stiegler, C. K. H. Dubose, R. E. Reed, Sr., and C. J. McHargue (Oak Ridge National Lab., Tenn.). Acta Met., 11: 851-60(Aug. 1963).

Dislocation configurations in deformed and annealed niobium single crystals were observed by transmission electron microscopy. Grown-in dislocations were observed to act as sinks for interstitials; this action retarded climb during annealing and possibly made the dislocations immobile during deformation. Three dimensional walls of dislocation tangles formed early in the deformation process and surrounded cells relatively free of dislocations. During the initial annealing stages, dislocations in the cell walls rearranged themselves to form well-defined small-angle boundaries between adjacent cells. After 1 hr at 700°C a few recrystallized grains, rotated 20–30 deg about [111] from the surrounding cell structure, were observed. Nucleation and growth of these particular recrystallized grains probably occurred because of the partial coincidence of lattice sites between them and the unrecrystallized material. Growth slowed down appreciably as the grains grew into material that did not bear the special orientation relationship with the recrystallized grain. Regions in which the grains were not nucleated recrystallized without a change in orientation by the gradual sweeping out of dislocations. (auth)

**29337** THE DIFFUSION OF GOLD, NICKEL, AND COBALT IN ALPHA IRON: A STUDY OF THE EFFECT OF FERROMAGNETISM UPON DIFFUSION. R. J. Borg and D. Y. F. Lai (Univ. of California, Livermore). Acta Met., 11: 861-6(Aug. 1963). (UCRL-7123)

Self-diffusion coefficients for Au, Co, and Ni in $\alpha$-Fe were determined between approximately 700 and 900°C. The magnetic effect was demonstrated by each of the three diffusing elements. Equations are given for the diffusion coefficients in the paramagnetic temperature region. The values of the activation energy for Ni and Co are substantially different from those previously reported by others. (P.C.H.)

**29338** THE DIFFUSION OF COBALT AND IRON IN PURE DELTA IRON. R. J. Borg, D. Y. F. Lai, and O. H. Krikorian (Univ. of California, Livermore). Acta Met., 11: 867-71(Aug. 1963). (UCRL-7124)

The diffusion of $Fe^{59}$ and $Co^{60}$ in $\delta$-Fe were measured using a sectioning technique. The diffusion penetrations were determined by counting the radioactivity in the sections removed and also by the residual activity method. The results are summarized by the equations: $D_{Fe} = 1.9 \exp[-57.0 \times 10^3/RT]$ and $D_{Co} = 5.5 \exp[-61.2 \times 10^3/RT]$. In both cases the activation energy and $D_0$ are significantly less than values previously reported for diffusion in the paramagnetic region of $\alpha$-Fe. This amounts to approximately a threefold decrease in the value of D below that expected from extrapolation of the $\alpha$-Fe data. The results indicate that were iron to retain the bcc structure at all temperatures, the activation energy would demonstrate a nonlinear functional dependence on temperature. (auth)

**29339** YIELDING AND PLASTIC FLOW IN NIOBIUM. L. I. Van Torne and G. Thomas (Univ. of California, Berkeley). Acta Met., 11: 881-98(Aug. 1963). (UCRL-10515)

A detailed comparison was made of the substructures and mechanical properties of polycrystalline niobium deformed at room temperature. The results show that the lower yield stress depends upon the total impurity content, and that solute atom clusters are the strongest barriers to dislocation motion. It was concluded, however, that impurities are not responsible for the temperature dependence of the yield stress. The yield drop is shown to be due to dislocation multiplication and the effect of grain size on the yield and flow stress appears to be significant through the dislocation density. Dislocation cell structures are formed only in impure Nb containing dispersed precipitates. In the purest Nb, dislocations are uniformly distributed, and the material exhibits very little work hardening. Work hardening was thus attributed to the long-range stress fields of cell walls or tangles. Dislocations were never observed to be extended and cross-slip is an easy process in Nb. This is consistent with Nb having an intermediate or high stacking fault energy. (auth)

**29340** INFLUENCE OF ALLOYING ON THE NEGATIVE THERMAL EXPANSION OF DELTA PLUTONIUM. K. A. Gschneidner, Jr. (Los Alamos Scientific Lab., N. Mex.), R. O. Elliott, and J. T. Waber. Acta Met., 11: 947-55(Aug. 1963).

The negative thermal expansion of delta plutonium became less negative and finally became positive with increasing amounts of alloying additions of aluminum, zinc, zirconium, indium, and cerium. The change in expansion can be correlated with electron concentration, $\eta$. The expansion is zero at a critical value of $\eta^* = 4.74$, relative to a value of 4.82 for pure delta plutonium, and is positive in alloys whose $\eta$ is less than 4.74. Several models that can be used to explain the observed behavior are discussed. A new method for estimating the metallic valence of delta plutonium is also described. (auth)

**29341** MICROSCOPIC OBSERVATION OF THE DEFORMATION OF BERYLLIUM IN THE FRAGILE ZONE. Pierre Pointu, Pierre Azou, and Paul Bastien (Ecole Centrale des Arts et Manufactures, Paris). Compt. Rend., 256: 4419-21(May 20, 1963). (In French)

The microscopic observation of Be during traction at room temperature to 1000° shows several deformation modes. It reveals, at the grain boundaries, above 500°, a liquid phase that provokes general decohesion. Decohesion can be avoided by thermal treatment of Be containing iron and aluminum with an Al/Fe ratio less than 0.8 to 1 (in weight). (tr-auth)

**29342** THE OBSERVATION OF DISLOCATIONS OBSERVED IN ZIRCONIUM DURING $\alpha \rightarrow \beta$ PHASE TRANSFORMATION. Jacqueline Devaud, Jean Pollard, and Pierre Lehr (CNRS, Paris). Compt. Rend., 256: 4426-8 (May 20, 1963). (In French)

Electron and optical microscopic observations show that the $\beta \rightarrow \alpha$ transformation of Zr during quenching is accompanied by the formation of dislocations. These dislocations tend to be grouped at polygonization walls when the quenching velocity is sufficiently slow. (tr-auth)

**29343** FRAGILIZATION OF NIOBIUM BY HYDROGEN AT ROOM TEMPERATURE: EFFECT OF OXYGEN IN SOLID SOLUTION AND OF THE DEFORMATION VELOCITY. Auguste Clauss and Roger Kieger (Université, Strasbourg). Compt. Rend., 256: 4429-31(May 20, 1963). (In French)

Niobium in the presence of hydrogen can manifest an abnormal fragility at room temperature just as Ta can. The role of oxygen in this fragility is investigated, and it is shown that elongation at rupture depends on the deformation velocity. (tr-auth)

**29344** A DEVICE PERMITTING THE ZONE FUSION OF ZIRCONIUM IN ULTRAVACUUM. Jean-Paul Langeron (CNRS, Paris). Compt. Rend., 256: 4436-9(May 20, 1963). (In French)

A vertical zone fusion device permitting work in ultravacuum was perfected. It is mounted entirely with metallic fittings. All problems of transmission of motion to the inside of the enclosure received magnetic solutions. An indium assembly gate allows the enclosure to be isolated from the pumping stations during fusion. (tr-auth)

**29345** DETERMINATION OF THE ANISOTROPY OF THE ELECTRICAL RESISTIVITY OF $\alpha$ URANIUM AT 180°C. Jacques Pascal, Jean Morin, and Paul Lacombe (École des Mines, Paris). Compt. Rend., 256: 4899-4902 (June 5, 1963). (In French)

Measurements of the electric resistivity at 180°C of 18 monocrystalline platelets of $\alpha$ U with different orientation have allowed the principle resistivities to be determined relative to the |100|, |010|, and |001| axes. The values obtained confirm a strong anisotropy of the electric resistivity, with the minimum value attached to the |010| direction. (tr-auth)

**29346** THE PHASE DIAGRAM OF $TiCr_2$–$NbCr_2$. I. I. Kornilov, K. I. Shakhova, P. B. Budberg, and N. A. Nedumov (Baikov Inst. of Metallurgy, USSR). Dokl. Akad. Nauk SSSR, 149: 1340-2(Apr. 21, 1963). (In Russian)

The intermetallic compounds $TiCr_2$ and $NbCr_2$ have similar crystallographic properties and have a polymorphic transition. The low-temperature modification of $TiCr_2$ exists up to 1300°C and that of $NbCr_2$ up to 1590°C. The results of thermal analysis showed that mixtures of $TiCr_2$ and $NbCr_2$ from 100% $TiCr_2$ to 100% $NbCr_2$ all have a polymorphic conversion with a transition temperature which rises monotonically on going from 100% $TiCr_2$ to 100% $NbCr_2$. A continuous series of solid solutions is formed not only between the high-temperature modifications, but also between the low-temperature modifications. The phase diagram shows the formation of a low-temperature $\gamma$ phase, a $\beta$ phase of $TiCr_2$, and a high-temperature $\delta$ phase. An x-ray phase analysis was run on the alloys after quenching from 1300°C and a long annealing at 1000°C for 200 hours. The results indicated the formation of a cubic modification, and pointed to the formation of a continuous series of solid solutions between the cubic modifications of the intermetallic compounds. (TTT)

**29347** CRYSTAL STRUCTURE OF COMPOUNDS IN THE Sc–Re SYSTEM. P. I. Kripyakevich, Yu. B. Kuzma, and V. S. Protasov (Lvov State Univ.). Dopovidi Akad. Nauk Ukr. RSR, No. 4, 492-5(1963). (In Ukrainian)

Two compounds were found in the Sc–Re system by the method of x-ray diffraction— $ScRe_2$ ($MgZn_2$ type, a = 5.271 ± 0.002 Å, c = 8.592 ± 0.004 Å, c/a = 1.630) and $Sc_5Re_{24}$ ($Ti_5Re_{24}$ type, a = 9.65 Å). In slowly cooled alloys the latter compound exists in equilibrium with Re. (auth)

**29348** ON THE CREEP OF TITANIUM–ZIRCONIUM–TIN ALLOYS. V. V. Glazova and N. N. Kurnakov. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 1, 161-7(Jan.-Feb. 1963). (In Russian)

The rate of creep of Ti–$Ti_3$ Sn–Zr solid solutions was studied at elevated temperatures. The creep-composition diagram was correlated with the constitution diagram, and an hypothesis on the influence of phase transformation $\alpha(\gamma) \rightarrow \beta$ temperatures on creep was confirmed. It was also shown that combined Zr and Sn alloying of $\alpha$ Ti is more effective in creep stabilization than separate alloying. (R.V.J.)

**29349** EFFECTS OF ALLOYING ELEMENTS ON RECRYSTALLIZATION OF MAGNESIUM. M. E. Drits, Z. A. Sviderskaya, E. S. Kadaner, and S. B. Fel'gina. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 1, 191-8(Jan.-Feb. 1963). (In Russian)

Effects of Th, Nd, Zr, Ni, and Ba on Mg recrystallization and strengthening at elevated temperatures were investigated. Constitution diagrams, microstructure, and recrystallization kinetics are given. (R.V.J.)

**29350** DIFFUSION COEFFICIENT IN NIOBIUM–CARBON SYSTEM. S. S. Nikol'skii. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 1, 199-200 (Jan.-Feb. 1963). (In Russian)

Diffusion of Nb and C in Nb, $Nb_2C$, and NbC at 1800°C was analyzed and diffusion coefficients were determined. (R.V.J.)

**29351** DIFFUSION OF NICKEL$^{63}$ IN SINGLE CRYSTALS OF LEAD SULFIDE. Martin S. Seltzer and J. Bruce Wagner, Jr. (Yale Univ., New Haven). J. Chem. Phys., 38: 2309-10(May 1, 1963).

Studies were carried out on the substitutional diffusion of $Ni^{63}$ in PbS crystals at 600 to 700°C. Stoichiometric PbS, PbS with excess Pb, and PbS with excess S were studied. The diffusion coefficients were of the order $10^{-14}$ to $10^{-12}$ $cm^2$/sec and several orders of magnitude smaller than those found by Bloem and Kröger for interstitial diffusion at low temperatures. The diffusion mechanisms are discussed. (D.L.C.)

**29352** X-RAY STUDY AND THERMOELECTRIC PROPERTIES OF THE $USi_xGe_{3-x}$ SYSTEM. L. H. Brixner (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Inorg. Nucl. Chem., 25: 783-7(July 1963). (In English)

A series of solid solutions of $USi_3$ and $UGe_3$ was prepared to demonstrate that complete solid solubility exists, with dependence on Vegard's Law. The electrical resistivity, Seebeck coefficient, and thermal conductivity were determined to characterize the compositions in the $USi_xGe_{3-x}$ system by their thermoelectric Figure of Merit. (auth)

**29353** HIGH TEMPERATURE X-RAY METALLOGRAPHY. I. A NEW DEBYE-SCHERRER CAMERA FOR USE AT A VERY HIGH TEMPERATURES. II. A NEW PARAFOCUSING CAMERA. III. APPLICATIONS TO THE STUDY OF CHROMIUM, HAFNIUM, MOLYBDENUM, RHODIUM, RUTHENIUM, AND TUNGSTEN. R. G. Ross and W. Hume-Rothery (Oxford Univ.). J. Less-Common Metals, 5: 258-70(June 1963).

Two x-ray cameras are described which can be used to very high temperatures. One of these is a Debye-Scherrer camera after the model of Westgren in which electric current for heating passes through the specimen itself, and this camera has been used up to 3100°C. In the application of this camera to Cr, Rh, Ru, and W, only the room temperature modifications were detected, while for Hf photographs were obtained of the high temperature b.c.c. modification. The other camera is of the symmetrical parafocusing type with a refractory metal heater surrounding the specimen. The specimen, which is in the form of a block of the material under study, has a small hole drilled in it which forms effectively a black body cavity for temperature measurement. This camera has been used to determine accurately the temperature variation of the lattice parameter of Mo up to 1733°C. (auth)

**29354** AN INVESTIGATION OF THE PHASE-DIAGRAM PALLADIUM–ARSENIC IN CONNECTION WITH SUPERCONDUCTIVITY. Ch. J. Raub and G. W. Webb (Univ. of

California, San Diego). J. Less-Common Metals, 5: 271-7 (June 1963).

The phase-diagram Pd–As was investigated by thermal, röntgenographic, and metallographic analysis, together with superconductivity measurements. The existence of five phases, three of them previously unknown, was established. Addition of arsenic to palladium causes a sharp drop of the liquidus curve. At 770°C the compound $Pd_7As$ is formed peritectically. Increasing the amounts of As causes the eutectic at 20 at. % As (715°C) to be followed by a peritectic reaction (820°C) between liquid and the congruently melting compound $Pd_5As_2$ (860°C), forming $Pd_3As$. At 33 at. % As the peritectically formed phase $Pd_2As$ (728°C), which transforms at 485°C into a low temperature modification exists. The homogeneity range of $PdAs_2$ was found not to be as broad as claimed earlier. Three of the compounds are superconductors: $Pd_5As_2$ ($T_c$ = 0.46°K), $Pd_2As$ h.t. ($T_c$ = 1.71°K) and $Pd_2As$ l.t. ($T_c$ = 0.60°K). (auth)

**29355** THE UC–UN AND ThC–ThN SYSTEMS. R. S. Street and T. N. Waters (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Less-Common Metals, 5: 295-7(June 1963).

The interdiffusion of UC and UN and of ThC and ThN was studied by forming pellets of carbide–nitride mixtures, firing them at 1600°C, and analyzing them by x-ray diffraction. The results for the ThC/ThN mixed phases confirms Vegard's Law and indicates that C and N diffuse readily at 1600°C in ThC and ThN. The UC/UN samples showed a stationary UC pattern and a more diffuse pattern from a UC/UN phase of varying composition. The possible causes of the decreased diffusion in UC are discussed. (D.L.C.)

**29356** GUIDE TO REFRACTORY CERAMICS. Jack E. Hauck. Mater. Design Eng., 58: No. 1, 85-96(July 1963).

The state-of-the-art and basic engineering properties of refractory ceramics are described. A review is presented on the characteristics of oxides, carbides, borides, nitrides, silicides, and other materials available today. A summary chart of the properties is given. (D.L.C.)

**29357** BINDING IN METALS. Harvey Brooks (Harvard Univ., Cambridge, Mass.). Trans. AIME, 227: 546-60(June 1963).

The theory of cohesive energy of metallic crystals is reviewed in the light of recent advances in the electronic theory of solids. A detailed study is presented for the cohesive energy, pressure-volume relations, and elastic shear moduli of some alkali metals, together with an estimate of the limits of error of the theory. The largest uncertainties are connected with the correlation and exchange energy of the valence electrons, and, in the case of the heavier elements, with the correlation between the valence electrons and the ion cores. A discussion is also given on the equation of state for polyvalent metals at extremely high pressures, and on the electronic structure of noble and transition metals. (auth)

**29358** THE DEVELOPMENT OF HIGH STRENGTH ALPHA–TITANIUM ALLOYS CONTAINING ALUMINUM AND ZIRCONIUM. D. N. Williams, R. A. Wood, H. R. Ogden, and R. I. Jaffee (Battelle Memorial Inst., Columbus, Ohio). Trans. AIME, 227: 563-71(June 1963).

The tensile properties, creep resistance, and thermal stability of highly alloyed Ti–Al–Zr alloys were examined. On the basis of the studies, the Ti–7Al–12Zr composition was selected for more complete evaluation. The alloy was found to be weldable and free from excessive directionality. In addition, it developed maximum properties without requiring heat treatment other than an annealing operation in the alpha field. (auth)

**29359** URANIUM DIFFUSIVITY IN LIQUID CADMIUM. J. C. Hesson and Leslie Burris (Argonne National Lab., Ill.). Trans. AIME, 227: 571-5(June 1963).

The diffusivity of uranium in liquid cadmium was measured as a function of temperature by the capillary-bath technique. The diffusivity measurements were made at 450, 500, 575, and 650°C, over which temperature range the diffusivity of uranium varied from 1.3 to $2.3 \times 10^{-5}$ $cm^2$ per sec. The diffusivity of uranium in cadmium was less than that predicted by the Einstein-Stokes equation. (auth)

**29360** DIFFUSION OF $Zr^{95}$ AND $Cb^{95}$ IN Bcc ZIRCONIUM. J. I. Federer and T. S. Lundy (Oak Ridge National Lab., Tenn.). Trans. AIME, 227: 592-7(June 1963).

Chemically purified $Zr^{95}$ and $Nb^{95}$ were used in determining self-diffusion coefficients in the bcc phase of iodide zirconium over the temperature range of 900 to 1750°C. The temperature dependence of the diffusion coefficients could not be described by the usual Arrhenius-type equation over the entire temperature range. Values of the apparent frequency factors $(D_0)_A$ and activation energies $(Q)_A$ for $ZR^{95}$ varied from $4.8 \times 10^{-6}$ to $2.5 \times 10^{-2}$ $cm^2$ per sec and 20700 to 46900 cal per mole, respectively, between 900 and 1750°C. Similarly, for $Nb^{95}$, values of $(D_0)_A$ and $(Q)_A$ varied from about $1.4 \times 10^{-5}$ to 0.25 $cm^2$ per sec and 26500 to 56800 cal per mole, respectively. The data may be described in terms of the $\alpha$ to $\beta$ transition temperature of 1136°K. (auth)

**29361** THE EFFECT OF SURFACE CONDITION ON THE MICROSTRAIN OF BERYLLIUM. W. Bonfield, J. A. Sartell, and C. H. Li (Honeywell Research Center, Hopkins, Minn.). Trans. AIME, 227: 669-73(June 1963).

The stress to cause a permanent microstrain of $2 \times 10^{-4}$ in. per in. (defined as the microscopic yield stress) in beryllium was found to be very sensitive to surface condition. The initiation of plastic flow in as-machined specimens, which contain a high density of twins and large residual compressive stresses to a depth of about 0.010 in. from the surface, occurs by the nucleation of slip from high stress fields around twin tips in the surface layers. Removal of the damaged surface layers by chemical polishing results in an appreciable increase in the microscopic yield stress, which is attributed to the removal of stress raising twins rather than to the release of residual stresses. (auth)

**29362** THE CRYSTAL STRUCTURES OF $Ti_2Cu$, $Ti_2Ni$, $Ti_4Ni_2O$, AND $Ti_4Cu_2O$. M. H. Mueller and H. W. Knott (Argonne National Lab., Ill.). Trans. AIME, 227: 674-8(June 1963). (ANL-FGF-396)

The crystal structures of $Ti_2Cu$, $Ti_2Ni$, $Ti_4Ni_2O$, and $Ti_4Cu_2O$ were determined using powder specimens examined by x-ray and neutron diffraction. Lattice constants were determined for all four phases using x-ray powder diffraction films. Atom positional parameters of all four phases were determined from observed neutron intensities. X-ray diffraction calculated intensity data were presented also for the phase $Ti_2Cu$ to point out the particular suitability of neutron diffraction in this case. Interatomic distances were determined using the positional parameters obtained from neutron diffraction. (auth)

**29363** MECHANISMS OF WORK HARDENING IN COLUMBIUM. D. P. Gregory (Pratt and Whitney Air-

craft, Middletown, Conn.), A. N. Stroh, and G. H. Rowe. Trans. AIME, 227: 678-86(June 1963).

The magnitude and variation with strain of the parameters activation volume, V*; activation energy, H; and frequency factor, A, in the Arrhenius equation for strain rate $\epsilon = Ae^{-(H-V^*\tau a)/kT}$ were determined for Nb single crystals and polycrystals. Comparison of dislocation structures in deformed Nb crystals as determined by transmission electron microscopy with the rate theory results suggests that formation of lattice vacancies at jogs in screw dislocations is responsible for thermally activated deformation of polycrystalline Nb. Single crystals appear to deform by a different mechanism. Work hardening in fully recrystallized fine grain Nb was found to result from simultaneous decrease in activation volume and in the number of mobile dislocations with increasing strain. Work hardening in recovered polycrystals was found to result from decrease in activation volume with strain only. (auth)

**29364** ATOMIC ARRANGEMENTS IN THE C14 LAVES PHASE $Zr(VCo)_2$. J. G. Faller and L. P. Skolnick (Univ. of Delaware, Newark). Trans. AIME, 227: 687-95(June 1963).

The distribution of cobalt and vanadium over nonequivalent crystallographic sites in C14-type $Zr(VCo)_2$ alloys was investigated. An anomalous x-ray scattering technique in which the separation in the scattering factors of two similar atoms can be enhanced was employed. Six alloys spanning the pseudobinary section $ZrV_{1.6}Co_{0.4}-ZrV_{0.6}Co_{1.4}$ at 10% steps showed a nonrandom compositionally dependent distribution. Specifically, at high vanadium content cobalt preferentially occupied sites of type (6h) and vanadium, sites of type (2a); at low vanadium content the reverse was observed. In addition to the distribution fraction $\Psi$, the structural parameters x and z were obtained. There was no significant deviation of the parameters from those obtained in the ideal C14 structure. Suggestions are made to account for the observed nonrandomness in the distribution of atoms on the two types of sites. (auth)

**29365** VISCOSITY OF BISMUTH, LEAD, AND ZINC TO 1000°C. Donald Ofte and L. J. Wittenberg (Mound Lab., Miamisburg, Ohio). Trans. AIME, 227: 706-11(June 1963).

The absolute viscosity coefficients and activation energies for viscous flow of bismuth, lead, and zinc are reported. The viscosities were measured in an oscillating cup viscosimeter from nearly 1000°C to within 1 degree of the melting point of zinc; 2 degrees of the melting point of lead; and in the supercooled condition of bismuth, 9 degrees below the melting point. Two methods of relating the change in the viscosity coefficient with temperature were compared. From the plot of the logarithm of viscosity ($\eta$) as a function of reciprocal absolute temperature (1/T), the equations of the lines which fit the data are: Bismuth $\text{Log}_{10}\eta = 0.3368\ (1000/T) - 0.3510$, Lead $\text{Log}_{10}\eta = 0.4506\ (1000/T) - 0.3338$, and Zinc $\text{Log}_{10}\eta = 0.6625\ (1000/T) - 0.3841$ where: $\eta$ = centipoise antilog T = °K. However, a better fit of the data to straight lines is obtained when the log $\eta$/T is plotted as a function of 1/T. The self diffusion coefficients for lead and zinc, calculated from the viscosity data, compare favorably with direct diffusion measurements. (P.C.H.)

**29366** MECHANICAL TWINNING IN Fe-5 WT PCT Be. R. H. Richman (Ford Motor Co., Dearborn, Mich.) and G. P. Conard, II. Trans. AIME, 227: 779-81(June 1963).

Some crystallographic aspects of the operative mechanical twin modes in a quenched Fe-5 wt% Be alloy are presented. A total of 111 grains containing 122 sets of twin directions was analyzed; of these, 11 pole loci could not be associated with 112, 013, or 045, but all 11 passed within 2 degrees of the coordinates 2,3,10. Pole locus results are tabulated. Analysis of numerous intersections of (112) twins corroborated previously determined crystallographic data for such twins. Twins on any of the systems other than (112) were invariably very thin and short in the polished sections, and no intersections of (045) or (2,3,10) with other twins could be found. (P.C.H.)

**29367** THE PERMEABILITY OF HASTELLOY B TO HYDROGEN. David W. Rudd (Western Electric Co., North Andover, Mass.), Donald W. Vose, and James B. Vetrano. Trans. AIME, 227: 781-3(June 1963).

Investigations on the permeability of Hastelloy B to hydrogen showed that the passage involves dissociated particles as the diffusion species. The rate of permeation for hydrogen is therefore proportional to the square root of the pressure. It was also found that the rate of permeation is inversely proportional to the thickness of the barrier. It was concluded that the permeation is a diffusion-controlled passage of hydrogen atoms through the metal membrane. (P.C.H.)

**29368** STUDY OF ANNIHILATION POSITRONS WITH ELECTRONS IN ORDERED ALLOYS. I. Ya. Dekhtyar, S. G. Litovchenko, and V. S. Mikhalenkov (Inst. of Metallurgy, Kiev). Ukr. Fiz. Zh., 8: 288-93(1963). (In Ukrainian)

The method of electron-positron annihilation was used to study the maximum pulses of conductivity electrons in alloys of $Ni_3Mn$, $Cu_3Au$, and CuAu in the ordered and unordered states. A decrease was found in the maximum pulses during the ordering of CuAu and $Ni_3Mn$ alloys, whereas no difference was observed in the $Cu_3Au$ alloy between the maximum pulses of the ordered and unordered states. A possible explanation of these effects is given from the point of view of possible splitting of the Brillouin zone into halves during ordering. (auth)

**29369** ON THE RELATIONSHIP BETWEEN MICROSTRUCTURE AND SUPERCONDUCTIVITY OF COLD-ROLLED AND HEAT-TREATED STRIPS OF SUPERALLOY OF NIOBIUM WITH 25 wt % Zr. Michael S. Walker, Roland Stickler, and Fred E. Werner (Westinghouse Research Lab., Pittsburgh). Z. Metallk., 54: 331-8(June 1963). (In German)

The microstructure and superconductivity of a cold-rolled and heat-treated Nb–25 wt % Zr alloy in strong magnetic fields were investigated. Precipitation occurred in this alloy between 500 and 800°C. The precipitated particles inhibited long-range rearrangement of dislocations during recovery of the deformed alloy. This led to a fine equiaxed cell structure. The alloy, aged at higher or lower temperatures, did not contain a second phase and showed large cells with walls preferredly oriented 45° to the rolling direction. The critical current density and its dependence on the field orientation was strongly dependent on the heat treatments. In cold-rolled samples that were heat treated at 700°C, the critical current density showed practically no anisotropy with the orientation of the field. Samples heat treated outside the precipitation temperature range showed a pronounced orientation dependence of the critical current density. It was concluded that an isotrope cell structure causes isotropy of current density and vice-versa. Recrystallization in a sample led to a decrease of the critical current density, while subsequent precipitation caused an increase. It was considered probable that internal stresses were important for the occurrence of high-current, high-field superconductivity in this alloy. (auth)

**29370** INVESTIGATION OF THE THREE-COMPONENT SYSTEMS OF $V_a$ and $VI_a$ METALS WITH BORON AND CARBON. Erwin Rudy, Friedrich Benesovsky, and Louis Toth. Z. Metallk., 54: 345-53(June 1963). (In German)

Alloys of the ternary systems V(Nb, Ta, Mo, W)–B–C were produced by hot pressing and annealing in vacuo and in an inert gas atmosphere or by arc melting. The temperature sections of these systems were determined by x-ray and metallographic techniques. Two new binary phases, $MoB_{12}$ and $WB_{12}$, and a ternary phase, $Mo_2BC$, were found during the investigation. Attempts were made to clarify the crystal structure of these compounds but the results are still incomplete. (auth)

## Radiation Effects

*Refer also to abstracts 29298, 29320, and 29330.*

**29371** (AGN-TP-42) FISSION GAS RELEASE FROM CYLINDRICAL FUEL AND FUEL PINS. H. S. Dreyer (Aerojet-General Nucleonics, San Ramon, Calif.). [1961]. Contract AT(10-1)-880. 17p.

A series of experiments, designated IB-7T, was performed to obtain information on fission gas release from the fuels (BeO–$UO_2$ and $UO_2$) used in the pin-type fuel elements of the ML-1 reactor. The objectives of the experiments were to determine the amount of fission gas released by a defective fuel pin, to study the plate-out of fission products in the system, and to study oxidation of the fuel by the coolant. A theory was developed and coded to extrapolate the experimental results to the full reactor. The tests were conducted with a miniature gas circulating loop submerged in the pool of the GETR. The theory developed, the equipment used, the experiments conducted, the test results, and the conclusions reached are described. These experiments were conducted as part of the Army gas-cooled reactor systems program. (auth)

**29372** (BMI-1634) POSTIRRADIATION RELEASE OF $Xe^{133}$ FROM PYROLYTIC CARBON. David L. Morrison, Thomas S. Elleman, Russell H. Barnes, Duane N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). June 3, 1963. Contract W-7405-eng-92. 18p.

Postirradiation measurements were made at 700 to 1500°C of the release of $Xe^{133}$ recoiled into pyrolytic carbon during neutron irradiation in contact with uranium or $UO_2$ powder. The time-dependent release from two types of pyrolytic carbon coatings, laminar and columnar, and from two crystallographic directions in a sample of pyrolytic graphite having a quite perfect crystal structure was studied. Below 1200°C, the release pattern from all specimens was identical: a high rate of loss of $Xe^{133}$ for several minutes followed by a slower release, which was maintained for over 5 hr of heating. The slower process gave an integral fractional release which was linear with the square root of the heating time. At 1200°C and above the initial rapid release persisted for longer times. The release from the laminar coatings was higher than from the other specimens. On the basis of a diffusion model, the apparent diffusion coefficients for the laminar coatings were $10^2$ to $10^3$ times higher than those for the columnar coatings, with activation energies of 33 and 17 kcal per mole for the laminar and columnar coatings, respectively. There appeared to be a structural dependence to the release from the more perfect specimen. The xenon release in the "a" direction occurred with a higher apparent diffusion coefficient and lower activation energy for temperatures up to 1200°C as compared to the release in the "c" direction. The activation energy for the release in "a" direction was 15 kcal per mole and the value in the "c" direction was 50 kcal per mole. (auth)

**29373** (CEA-2217) ETUDE THEORIQUE ET EXPERIMENTALE D'UNE TECHNIQUE CALORIMETRIQUE DE MESURE DES DEPOTS D'ENERGIE DANS LES MATERIAUX DUS AU RAYONNEMENT COMPLEXE DE PILE. (Theoretical and Experimental Study of a Calorimetric Technique for Measuring Energy Deposition in Materials Caused by Complex Pile Irradiation). P. Mas, P. Sciers, and Y. Droulers (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1962. 45p.

Calorimetric methods may be used to measure gamma fluxes greater than $10^6$ r/h near the cores of swimming pool reactors. The theory, design, and properties of isothermal calorimeters are discussed, and experimental results obtained with two types are presented. Measurement of energy deposition in materials and the long term integration of energy depositions are other uses of these devices. Results of measurements on heat deposition in steel and water are given. Fluxes were also measured. (auth)

**29374** (GA-4138) IRRADIATION BEHAVIOR OF BeO–$UO_2$ FUEL AS A FUNCTION OF FUEL-PARTICLE SIZE. Dale E. Johnson and R. G. Mills (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Apr. 16, 1963. Contract AT(04-3)-187. 25p.

One capsule containing BeO–30 vol % $UO_2$ fuel pellets was irradiated to a uranium burnup of approximately 30,000 Mwd/t. The results of a microscopic examination and physical measurements made during the hot-cell examination of the capsule were described. (auth)

**29375** (HW-SA-3012) THE EFFECTS OF COLD WORK AND NEUTRON IRRADIATION ON THE TENSILE PROPERTIES OF ZIRCALOY-2. A. L. Bement and J. E. Irvin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 18, 1963. Contract AT(45-1)-1350. 29p.

Neutron irradiations at 300°C were conducted on Zircaloy-2 tensile specimens in a hot-water loop of the Engineering Test Reactor. The tensile specimens contained 0, 20, and 40% cold work prior to irradiation and represented both the transverse and longitudinal directions with respect to rolling. Tensile data were obtained both at room temperature and 300°C for specimens irradiated to exposures up to $10^{21}$ neutrons/$cm^2$ (fast). These data are compared to control data from hot-water loop exposures that simulate the in-reactor environment except for the neutron flux. Unirradiated Zircaloy-2 displays marked directional effects in both strength and ductility. This anisotropy results from the preferred orientations introduced by either cold rolling or recrystallization and the effects of these orientations on deformation processes. Directional effects persist after irradiation. With combinations of cold work and stress direction for which plastic deformation is non-homogeneous, irradiation hardening can greatly increase anisotropy in mechanical properties. For example, the uniform strain of annealed Zircaloy-2 stressed in the transverse direction is reduced to less than 1% with exposures as low as $10^{20}$ neutrons/$cm^2$. After a similar exposure longitudinal specimens display more than 5% uniform strain. There is evidence that thermal cold work recovery occurs during neutron irradiation due, perhaps, to interactions between dislocations and irradiation-induced defects. (auth)

**29376** (HW-SA-3040) USE OF AUTORADIOGRAPHY IN MICROSAMPLING OF IRRADIATED CERAMIC FUEL

ELEMENTS. R. Teats (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 10, 1963. Contract AT(45-1)-1350. 4p.

The use of autoradiographs in conjunction with microsampling techniques for examination of irradiated fuel elements is discussed. Methods and equipment are described. (M.C.G.)

**29377** (NARF-63-1T) HOT-FLOW CHARACTERISTICS OF IRRADIATED POLYETHYLENE. E. G. Fritz and P. M. Johnson (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). May 15, 1963. Contract AF33(657)-7201. 33p. (MR-N-300; AD-407515)

Polyethylene disks, 0.55 in. diameter by 0.137 in. thick, were irradiated in air in the Ground Test Reactor to five different gamma-ray dose levels: $2.2 \times 10^8$, $4.72 \times 10^8$, $1.64 \times 10^9$, $4.99 \times 10^9$, and $1.33 \times 10^{10}$ ergs/gm(C) plus the dose imparted by the associated neutron flux. After irradiation, the samples were compressed in a parallel-plate plastometer under constant load of 260°F for a period of five minutes. The thickness and the diameter of the extruded samples were measured at 75°F and found to be correlated with the absorbed gamma-ray dose in a manner described by two empirically derived equations. An evaluation of the radiation-induced change in viscosity, $\eta$, of the disks showed that the dose region where $\eta$ departs from linearity is coincident with the most sensitive region of response in the hot-flow characteristics [$10^8 - 1.5 \times 10^9$ erg/cm(C)]. The results suggest that in this dose region, the described experimental procedure may be usefully employed for dosimetric purposes. (auth)

**29378** (NARF-63-2T) COMPRESSION-SET BEHAVIOR OF IRRADIATED SILICONE ELASTOMERS. E. G. Fritz and P. M. Johnson (General Dynamics/Fort Worth, Div. of General Dynamics Corp., Forth Worth, Tex.). May 15, 1963. Contract AF33(657)-7201. 35p. (MR-N-301; AD-406689)

The effect of nuclear radiation (5 different dose levels in the range from $10^8$ to $10^{10}$ ergs/g(C)) on the compression-set behavior of 3 types of silicone elastomers was examined. During the irradiation the samples were compressed at constant strain in an air environment. The observed post-irradiation percent compression set after an accumulated dose was described by an empirically derived equation. The ratio of the number of network chains at equilibrium with the unstrained thickness to the number of network chains at equilibrium with the applied strain rapidly decreased with dose. The Shore-A hardness of these elastomers was observed to increase with dose. Within the dose region investigated, the hardness attained after an accumulated dose can be expressed by an empirically derived equation. (auth)

**29379** (NRL-5930) IN-PILE HALL COEFFICIENT AND CONDUCTIVITY MEASUREMENTS ON ZONE-REFINED P-TYPE SILICON. Interim Report. G. C. Bailey and C. M. Williams (Naval Research Lab., Washington, D. C.). Feb. 19, 1963. 12p. (AD-407073)

The Hall coefficient and conductivity were measured during pile irradiation for a number of zone-refined p-type silicon crystals with initial resistivities of 1, 8, and 100 ohm-cm. To supply the magnetic field (500 oersteds) for the Hall measurements in the reactor, a small electromagnet was used. The conductivity of zone-refined silicon shows much faster changes with irradiation than pulled silicon samples of equivalent resistivity. The 100-ohm-cm samples exhibit a monotonic nonlinear decrease of ln $\sigma$ (conductivity) vs $\phi_f$ (integrated fast flux), whereas the other samples with initial Fermi levels closer to the valence band have one or two regions of linear decrease in ln $\sigma$ vs $\phi_f$ before the nonlinear decrease region is observed. The Hall mobility for the 100-ohm-cm samples decreases and becomes negative as a result of the carrier density decreasing with irradiation. In the case of the 8-ohm-cm sample, the Hall mobility decreases with irradiation, whereas the 1-ohm-cm sample shows no change in Hall mobility with irradiation up to the maximum integrated flux used in the present experiment. The origins of the dependence of ln $\sigma$ on $\phi_f$ as well as the behavior of the Hall coefficient and Hall mobility with irradiation are discussed. (auth)

**29380** STRUCTURAL CHANGES IN IRRADIATED BeO. Harry L. Yakel and Bernard Borie (Oak Ridge National Lab., Tenn.). Acta Cryst., 16: 589-93(July 10, 1963). (In English)

X-ray-diffraction studies of polycrystalline beryllium oxide irradiated to $1.5 \times 10^{21}$ nvt ($E_n > 1$ Mev) at 110°C showed selective symmetric or asymmetric broadening of reflections hk · l with l not zero. Displacements of reflection maxima and centroids occur in such a manner that a unique $a_3$ lattice parameter cannot be defined from spacing measurements. Models of clustered interstitial and vacancy defects in a damaged BeO lattice are proposed and x-ray scattering from the models was calculated. Comparison of theoretical and experimental results indicates that the best agreement is obtained for an interstitial cluster model. Some physical implications of the model are discussed. (auth)

**29381** THE JOINT EFFECT OF MERCURY AND IRRADIATION ON THE MECHANICAL PROPERTIES OF ZINC SINGLE CRYSTALS. O. A. Troitskii and V. I. Likhtman (Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 149: 1115-8 (Apr. 11, 1963). (In Russian)

The $\beta$, $\alpha$, and $\gamma$ emitters $P^{32}$, $Pu^{239}$, and $Co^{60}$ were used to irradiate samples of single crystals of zinc 10 mm long and ~1 mm in diameter, which were grown by zone melting. After etching the surface with 20% $HNO_3$, about 3% wt % of Hg was put on the zinc surface by contact with a $HNO_3$ solution containing mercury. Tests on a Polyani instrument (elongation at a constant rate of deformation of ~10% $min^{-1}$ at 20 and –196°C) showed that the amalgamated, zinc single crystals, irradiated for 1550 hours in the $\alpha$, $\beta$, and $\gamma$ irradiators, suffered a significant loss in plasticity and strength. At first, there was a maximum increase in strength of +35% for a 16 to 18 hour irradiation, and a significant loss in strength and plasticity after 100 hours of irradiation with a 200 $\mu$C source of $P^{32}$. Since the loss in strength and plasticity was even more pronounced on irradiating the amalgamated, zinc single crystals with $\alpha$ particles of $Pu^{239}$, it was concluded that the role of surface, structural defects due to irradiation play an important part in the loss of strength and ductility. (TTT)

**29382** EFFECT OF PENETRATING RADIATION ON THE PRODUCTION OF PERSISTENT INTERNAL POLARIZATION IN ELECTRET-FORMING MATERIALS. Preston V. Murphy, Sergio Costa Ribeiro, Fernando Milanez, and Rogerio J. de Moraes (Universidade Católica, Rio de Janeiro). J. Chem. Phys., 38: 2400-4(May 15, 1963).

The electret state was produced in Teflon and carnauba wax by simultaneous action of penetrating radiation and an electric field. Polymethylmethacrylate, polyvinylacetate, polystyrene, polyethylene, and nylon did not form

electrets under these conditions. The shapes of isothermal decay curves and thermal depolarization "glow curves" were used to calculate activation energies for the depolarization process in Teflon. The average activation energy as calculated from the "initial rise" of thermodepolarization curves was 0.93 ev. The persistent heterocharge of carnauba wax and of certain polymers may be caused by the orientation of dipolar units composed of a positive molecular ion and a partially solvated electron. (auth)

**29383** PARAMAGNETIC SUSCEPTIBILITY OF IRRADIATED $UO_2$. L. Weil and J. Cohen. J. Phys., 24: 76-7(Jan. 1963). (In French)

The susceptibility of $UO_2$ was measured before and after neutron irradiation. A widening of the susceptibility around the Neel point is observed. However, x-ray studies show that the rays remain the same in position and length. In antiferromagnetic bodies, the length of the susceptibility maximum around the Neel point measures the magnitude of a fluctuation zone in the vicinity of the order-disorder transformation temperature. It increases in $UO_2$. It is assumed that the widening of the fluctuation zone is caused by interstitial faults insufficient to perturb the cell measurably, but which modify the energies of the antiferromagnetic coupling. (J.S.R.)

**29384** ALTERATION OF THE PROPERTIES OF STEEL BY LOW IRRADIATION DOSES IN DEPENDENCE ON THE IRRADIATION TEMPERATURE. P. Bettzieche, F. Bruehl, H.-J. Wiester, F. Stibbe, and J. J. Went. Nukleonik, 5: 148-53(June 1963). (In German)

Tensile strength and hardness tests were carried out on various steels irradiated at different temperatures to a maximum of $9 \times 10^{17}$ n/cm$^2$. The irradiation spectra were ascertained, and the test temperatures were controlled and measured exactly. The experimental apparatuses and methods are described. The low available irradiation energy was investigated with regard to the influence on the yield point as compared with previous results. With regard to irradiation at higher temperatures it was proved that for damaging steel parts by nuclear radiation an operation temperature of 300 to 350°C is expedient. (tr-auth)

# PHYSICS

## General and Miscellaneous

**29385** (BNL-7094) DYNAMICS OF ATOMIC DISPLACEMENT PROCESSES. I. PRIMARY ENERGIES NEAR THRESHOLD. Cavid Erginsoy (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 39p.

A model including directional and many-body effects without arbitrary assumptions is used to examine the kinetic energies transferred to successive atoms and the velocities in collision chains, as well as the displacement mechanism. The key mechanism of displacement at low energies is found to be a dynamic replacement by the knock-on (an atom replaces its neighbor). The associated replacement chains propagate with shock wave velocities. The threshold energy for displacing an atom is found to depend heavily on direction. This dependence makes the integrated probability of displacement a slowly rising function of knock-on energy, in contrast to the step-function form of the simple displacement theory. (D.C.W.)

**29386** (CEA-2239) ÉTUDE DE BOBINAGES SUPRACONDUCTEURS EN $Nb_3Sn$. (Study of Superconducting $Nb_3Sn$ Coils). B. Vivet (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1963. 30p.

Composite superconducting $Nb_3Sn$ wires with a diameter of 0.5 mm and a length of about 100 m were made, and Hc–Ic diagrams were plotted up to fields of 80 kgauss for short lengths. Two solenoids producing fields of about 20 kgauss were studied. $Nb_3Sn$ solenoids, as opposed to those of Nb–Zr or Nb–Ti, appear to have a predictable behavior. Solenoids with less insulation produced stronger fields than heavily insulated solenoids. (auth)

**29387** (CERN-63-18) GENERALISATION CIRCULAIRE ET RELATIVISTE DE L'EQUILIBRE DU FAISCEAU DE BRILLOUIN. (Circular and Relativistic Generalization of the Equilibrium of Brillouin Beams). P. Gratreau (European Organization for Nuclear Research, Geneva). May 7, 1963. 11p.

The circular generalization of the equilibrium conditions of the "solid" Brillouin beam is found. The beam is considered to be an annular beam of monoenergetic particles and is considered to be space-charge-limited. In the relativistic domain, the equilibrium conditions for this beam reduce to the conditions for the solid Brillouin beam. The effects of magnetic fields on the equilibrium conditions are studied. (T.F.H.)

**29388** (EUR-231.d) METHODEN UND ANWENDUNGEN DER ULTRA-HOCHVAKUUM-TECHNIK. (Methods and Applications of Ultra-High Vacuum Techniques). H. Eschbach (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. Central Nuclear Measurements Bureau, Geel, Belgium). 1963. 16p.

Methods of generating and measuring extremely low pressures are described. The factors which determine the final vacuum are discussed, and it is pointed out that measurements made in an ultrahigh vacuum, as well as such in vacuum physics in general, are difficult. It may be expected that mass spectrometry in an ultrahigh vacuum will be of progressively increasing importance. Likewise, new impulses of development in future ultrahigh vacuum methods may be expected from research into interaction between gases and surfaces of solids. In larger systems technological difficulties still prevail in the execution of releasing metal joints and in metal valves of very high throughput. Certain examples of this are discussed. Among the various applications mentioned are ultrahigh vacuum evaporating techniques and the generation of an ultrahigh vacuum in large-size altitude chambers. (auth)

**29389** (LADC-5786) METALLOGRAPHY OF THERMIONIC CONVERSION COMPONENTS. T. I. Jones (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 18p.

Fabrication problems in development of thermionic cells are discussed. Metallographic preparation of a plasma thermocouple with cesium gas and a UC–ZrC fuel pin is described. Mounts for the larger-size specimens were prepared. Techniques were developed to join the fuel pin to the body and the collector to the $Al_2O_3$ insulator. Figures are included for all steps. (M.C.G.)

**29390** (LAMS-2882) SOME APPROXIMATE CALCULATIONS OF THE WALL PRESSURE PROFILE FOR THE CASE OF A CHAPMAN-JOUQUET DETONATION IN A FINITE MASS OF HIGH EXPLOSIVE ADJACENT TO A RIGID WALL. Kenneth A. Meyer (Los Alamos Scientific Lab., N. Mex.). Feb. 1, 1963. Contract W-7405-eng-36. 74p.

The problem of the detonation of a slab of high explosive adjacent to a rigid wall with a vacuum as the other boundary was considered. The reflected shock was computed using Whitham's approximation. The pressure profile at the wall was computed by various approximate methods and results were compared with those obtained from a numerical solution using a Lagrangian code. (auth)

**29391** (NP-12920) AN APPLICATION OF LANGMUIR-TAYLOR DATA TO THE THERMIONIC CONVERTER. W. B. Nottingham (Thermo Electron Engineering Corp., Waltham, Mass.). [nd]. 18p. (TEE-7002-8)

Alternate ways of presenting the Langmuir-Taylor data can be of considerable practical interest to the designer of a thermionic converter of the cesium diode type. Principally, the analysis applies to the alteration of the emitter work-function as determined by the temperature of the emitter and the temperature of the cesium concentration control. Taylor-Langmuir results permit one to determine approximate values for the thermionic emission capability of a tungsten surface operated at any specified temperature between 1200 and 2400°K and a cesium-bath from 500 to 640°K. The ratio of the ion production and the corresponding electron production is analyzed, and an area of operation is defined in which the current density can be large and yet have a sufficient ion production not only to neutralize space charge but to create an ion sheath over the emitter to accelerate the electrons into the highly ionized plasma region of the diode. (auth)

**29392** (NP-12951) ANNUAL REPORT [ON PHYSICS], APRIL 1962–MARCH 1963. (Tokyo Univ. Inst. for Nuclear Study). Mar. 31, 1963. 54p.

Research in low energy physics, high energy physics, cosmic radiation (air showers, cosmic radiation (balloon flights), theoretical physics, and chemistry is reported. (D.C.W.)

**29393** (TID-17080) THE USE OF POWDER REFLECTION INTENSITIES TO PREDICT PHYSICAL PROPERTIES

IN ORIENTED MATERIALS. E. F. Sturcken (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 1962. Contract AT(07-2)-1. 23p.

The spectrometric powder method is commonly used to measure relative diffraction intensities for the identification of polycrystalline materials. Because of the geometry of diffraction, the integrated diffraction intensity from each reflection, (hkl), is proportional to the volume of crystallites (grains) having a specific orientation of the crystallographic axes with respect to the normal to the surface of the sample. The set of discrete reflection intensities is used to synthesize a continuous grain orientation distribution function, $P(u,\phi)$. The symbols u and $\phi$ specify the angles that the crystallographic axes of the grain make with the normal to the sample surface, and $P(u,\phi)$ gives the number of grains oriented in each direction, $(u,\phi)$. $P(u,\phi)$ is obtained from a least squares fit of the diffraction intensities to an orthonormal set of spherical harmonic functions. The $P(u,\phi)$ function is used in conjunction with the strain tensor concept to develop an equation for predicting thermal expansion coefficients. The equation gives good agreement between measured and calculated thermal expansion coefficients for rolled uranium sheet. A completely automated method is described for measuring and analyzing the diffraction intensities. (auth)

**29394** (NRL-5935) CALCULATION OF MAGNETIZATION VS TEMPERATURE CURVES FOR FERRIMAGNETIC MATERIALS. Interim Report. E. Prince (Naval Research Lab., Washington, D. C.). Feb. 28, 1963. 11p. (AD-407420)

The equations implicit in Néel's molecular-field theory of ferrimagnetism are set out in considerable detail. The general equations that pertain to magnetic structures with crystallographic long-range order are derived, and the specific pair of transcendental equations that must be satisfied in the case of two sets of antiparallel magnetic spins are written down in a form that is amenable to solution by automatic computer methods. The dominant interaction is expressed in terms of the magnetic transition temperature, while the two smaller interactions are given as fractions of the dominant one. A computation of the shapes of the curves of the magnetization as a function of temperature shows that, while magnetic and neutron diffraction measurements can determine quite precisely the value of a linear function of these fractions, the actual values of the individual fractions are less precisely determined. It follows that any experimental deviation from the calculated curves is due to an inadequacy of the theory rather than to incorrect values of the parameters. Finally, methods of attack for computation of more complex cases are discussed. (auth)

**29395** (TID-17152) CORRELATION FUNCTION FOR THE HELIUM $1^1S$ STATE. O. C. Simpson and D. McColl (Argonne National Lab., Ill.). Aug. 1962. Contract W-31-109-eng-38. 18p. (UAC-6718)

Tables of values and graphs of the correlation function for the $1^1S$ state of the helium atom are given for two different helium $1^1S$ functions, and some comparison of Hartree-Fock and Hylleraas wave functions for the helium ground state is made. (auth)

**29396** (TID-18947) COPPER MASS ABSORPTION COEFFICIENTS FOR LOW ENERGY X-RAYS. R. W. Carter, G. R. Dyer, and R. H. Rohrer (Emory Univ., Atlanta). [nd]. Contract AT(40-1)-2953. 10p.

Experimental values of the mass absorption coefficient of copper as a function of photon energy were determined in the x-ray energy range from 1.5 to 18 kev. These values were compared graphically with values calculated by semi-empirical formulas. In general, good agreement is obtained between the present experimental values and those calculated by the method of Victoreen. (auth)

**29397** (TID-18984) PHOTOELECTRIC EFFECT INDUCED BY HIGH-INTENSITY LASER LIGHT BEAM FROM QUARTZ AND BOROSILICATE GLASS. J. J. Muray (Stanford Univ., Calif. Stanford Linear Accelerator Center). [1962]. Contract AT(04-3)-115. 17p.

Using a high-intensity light beam from a ruby laser, the number of photoelectrons from quartz and the number of photoelectrons for borosilicate glass were measured as a function of the laser output power. The number of electrons was an exponential function of the field in the light beam. The delay between the maximum of the electron current and maximum intensity of the light pulse decreased with increasing output power. Previous low-intensity experiments on photoelectron emission from borosilicate glass showed that the photon energy must exceed 4.9 ev, but in the present experiments electron emission was observed with 1.78-ev photons. Thus the experiments cannot be explained purely on the basis of the photoelectric effect. However, by using the theory of thermal breakdown in a dielectric surface, the observed electron current as function of the light beam power can be explained. The yield of electrons from borosilicate glass exceeded the yield from quartz at the same photon intensities. (auth)

**29398** (UCRL-6892) ANALYTIC APPROXIMATIONS TO THE SOLUTIONS OF THE SAHA EQUATIONS FOR A MULTIPLY IONIZED SYSTEM. Francis H. Ree (California. Univ., Livermore. Lawrence Radiation Lab.). Apr. 26, 1962. Contract W-7405-eng-48. 13p.

The free electron concentrations for a multiply ionized system in ionization equilibrium are given as solutions of quadratic equations. The coefficients of the quadratic equations contain several (1 to 5) equilibrium constants of various ionic species that participate most significantly in the ionization process at given temperature and density. The present method is generally applicable to the overall gaseous temperature range of the substance in question, provided that all the equilibrium constants relating each ionic species are known. Calculations of C. Rouse by an iterative technique are compared with the results of the present method by using equilibrium constants obtained from the law of mass action. The differences between the two results are negligible. (auth)

**29399** (AEC-tr-5876) THE LOWEST CHARACTERISTIC ENERGY LOSS OF 25 kev ELECTRONS AS A FUNCTION OF THE LAYER THICKNESS DURING IRRADIATION OF THIN Ag-LAYERS. A. Otto and W. Steinmann. Translated for Oak Ridge National Lab., Tenn. from Phys. Status Solidi, 2: K187-91(1962). 6p.

The difference in values obtained when the energy loss suffered by electrons passing through Ag layers was determined from optical constants and radiation measurements and from loss measurements is explained. The volume loss is noted to depend on the layer thickness while the surface loss is independent of it. Therefore, as the layer thickness increases the volume loss becomes more apparent, and the maximum of the loss line shifts to higher energies. Experimental evidence for this explanation is presented. (D.C.W.)

**29400** (AEC-tr-5892) HEAT CONDUCTION IN ELECTRICALLY INSULATING CRYSTALS. Guenther Leibfried and Ernst Schloemann. Translated for Oak Ridge National

Lab., Tenn. from Nachr. Akad. Wiss. Goettingen, Math.-Physik. Kl., IIa. Math.-Physik.-Chem. Abt., 71-93(1954). 36p.

Heat conduction by lattice vibrations in electrically conducting crystals is discussed. Formulation of the lattice wave collision function is presented. Separation of the thermal motion according to propagating waves is described. An approximation method for calculation of heat conductivity is given and compared with experiment. (M.C.G.)

**29401** (NP-tr-1039) INDUCTANCE OF TOROIDAL COILS. R. Cazenave. Translated by B. C. Hodge (U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Rev. Gen. Elec., 59: 169-74 (1950). 21p. (Includes original, 6p.).

The inductance of a toroidal coil was determined. It is shown that the value of this inductance is greater than the approximate value given by elementary theory, from which it is derived. Attention is drawn to the advantages offered by an arrangement in which the greatest dimension of the coil profile is perpendicular to the axis of the coil, so as to give maximum inductance. The method of calculating the inductance of toroidal coils of various standard profiles is described. (M.C.G.)

**29402** MEASUREMENT OF THE RELATIVISTIC TIME DILATION USING $\mu$-MESONS. David H. Frisch and James H. Smith (Massachusetts Inst. of Tech., Cambridge). Am. J. Phys., 31: 342-55(May 1963).

An experiment was performed to demonstrate the relativistic time dilation as a large effect, using only comparatively simple equipment. Mesons($\mu$) were selected to have speeds in the range between 0.9950 c and 0.9954 c. The number of these that reached sea level was measured. The number expected without time dilation was calculated from the distribution of decay times of these mesons($\mu$) and from the known distance of descent. The observed time dilation factor is $8.8 \pm 0.8$ to be compared with the effective time dilation factor calculated for mesons of these speeds in the detection geometry. (auth)

**29403** SPECIAL NATURE OF ORBITAL ANGULAR MOMENTUM. James D. Louck (Auburn Univ., Ala.). Am. J. Phys., 31: 378-83(May 1963).

The properties of orbital angular momentum operators are examined within the framework of the formal theory of angular momentum. It is demonstrated that the occurrence of only integral quantum numbers in the orbital theory is a consequence of the particular form of the orbital operators. Single-valuedness of the eigenfunctions need not be postulated. (auth)

**29404** STRESS EFFECTS DUE TO LORENTZ CONTRACTION. Edmond M. Dewan (Air Force Cambridge Research Labs., Bedford, Mass.). Am. J. Phys., 31: 383-6(May 1963).

Relativistic stress effects caused by the Lorentz contraction are related to implications of relativistic simultaneity. This relationship is discussed in some detail, in order to clarify certain pedagogically difficult aspects of the problem. Objections are also answered. (auth)

**29405** S-MATRIX SOLUTION FOR THE FORCED HARMONIC OSCILLATOR. R. W. Fuller, S. M. Harris, and E. Leo Slaggie (Columbia Univ., New York). Am. J. Phys., 31: 431-9(June 1963).

The exact solution for a forced, undamped quantum harmonic oscillator is obtained by S-matrix techniques. The force F(t) is assumed to vanish at $t = \pm \infty$. The only restriction is that the Fourier transform of F(t) must exist. The transition probabilities are obtained in closed form in terms of Laguerre polynomials. The mean energy transfer to the oscillator is found to be independent of the initial state and is in agreement with the classical result for an oscillator originally at rest. This problem provides a good example of field theoretical procedures in an elementary context. Therefore, all field theoretical concepts are carefully defined and explained as they are introduced in order that the discussion may be self-contained. (auth)

**29406** STABILIZATION OF A HOT-CATHODE P.I.G. DISCHARGE IN A MAGNETIC FIELD. M. A. Allen, P. Chorney, and H. S. Maddix (Microwave Associates, Inc., Burlington, Mass.). Appl. Phys. Letters, 3: 30-1(July 15, 1963).

The stabilization of low-pressure, large-diameter discharges in magnetic fields was achieved by incorporation of a gridded structure over the cross section of the column that effectively reduced the plasma diffusion length in the radial direction and resulted in an increase in the critical magnetic field. The discharge configuration studied was a partially ionized gas discharge at $10^{-3}$ to $10^{-1}$ Torr. The gases investigated were argon, krypton, and xenon. (C.E.S.)

**29407** THE GRAVITATIONAL RADIATION OF A SYSTEM OF MOVING BODIES. J. Ryteń (Inst. of Physics, Polish Academy of Sciences, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 213-18(1963). (In English)

The gravitational radiation of an isolated system of N bodies moving arbitrarily is considered. The general formulas for computing the radiation are obtained. Field equations are solved and the final formula for the radiation is derived. A simple example of two bodies is illustrated, and the result obtained is identical with that of the linearized theory. (C.E.S.)

**29408** THE FOKKER ACTION PRINCIPLE AND THE GRAVITATIONAL RADIATION. J. Ryteń (Inst. of Physics, Polish Academy of Sciences, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 219-21(1963). (In English)

The non-vanishing radiation term for the gravitational radiation of a system of moving bodies appears in the equations of motion of the ninth order. The ninth order of the Fokker action principle from which the equations of motion in general relativity can be derived was investigated for the vanishing of its surface integral. (C.E.S.)

**29409** MULTIPLE IONIZATION OF ZINC BY ELECTRON BOMBARDMENT FROM 0 TO 500 v. Florence Fiquet-Fayard and Jean-Pierre Ziesel (Faculté des Sciences, Orsay, France). Compt. Rend., 256: 4885-8 (June 5, 1963). (In French)

It is shown that $Zn^{3+}$ is formed principally by the Auger effect following ionization in the M shell. The abundance at 500 v of ions produced by this process is much higher than the abundance of ions produced by simultaneous splitting off of three electrons. (tr-auth)

**29410** GROUND MULTIPLET OF THE SPARK SPECTRUM OF PLUTONIUM. Jacques Bauche, Jean Blaise, and Mark Fred (CNRS, Bellevue, France and Argonne National Lab., Ill.). Compt. Rend., 256: 5091-3(June 10, 1963). (In French)

The structure of the ground multiplets $5f^6\ 7s(^8F$ and $^6F)$ of the spark spectrum of Pu and the values of the Landé factors of these levels were determined. The positions of six missing levels were predicted by application of the $J_j$ coupling theory; the comparison of the experimental and theoretical results is very satisfactory. (tr-auth)

**29411** ON THE FORMATION OF THE ANODE SPACE OF A SHORT-TIME HIGH-INTENSITY ELECTRIC DISCHARGE. V. Hermoch (Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 13: 321-6(1963). (In English)

The formation of the anode region was studied by a new method. Stratified electrodes permitted the magnitude of the thermal flow to the electrodes to be changed while keeping the anode material the same, and a distinction could, therefore, be made between the influence of the properties of the electrode material and that of the composition of the plasma on the contraction. The results proved the dependence of the formation of the anode region on the physical-thermal properties of the anode material and confirmed the earlier hypothesis on the causes of contraction. They also explain some of the effects connected with the formation of a discharge, such as the change in contraction with time and with the motion of electrodes. (auth)

**29412** THE ANODE SPACE OF SHORT-TIME HIGH-INTENSITY ELECTRIC DISCHARGES. V. Hermoch (Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 13: 327-34(1963). (In English)

The influence of electrode evaporation on the forming of an anode region of short-time discharges has so far been neglected. A comparison of the amount of vapors produced in spots and the magnitude of the thermal flow to the electrodes for anodes of different materials shows the important connection between the formation of spots on electrodes and the flow of vapors and permits the characteristic effects (high current density in spots, splitting of spots, two forms of contraction) of the anode region of the given type of discharge to be explained. (auth)

**29413** THERMOELECTRIC PROPERTIES OF $Ce_2S_3$. V. I. Marchenko and G. V. Samsonov (Inst. of Metalloceramics, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 4, 463-6(1963). (In Ukrainian)

The temperature dependence of the thermal emf of $Ce_2S_3$ over a temperature range of 200–1000°C. In the impurity conductivity region (100–600°) the thermal emf is positive and changes in inverse proportion to the temperature in accordance with the relation established by N. L. Pisarenko. At a temperature of 700–800°C the thermal emf changes its sign. At a temperature above 800°C $\alpha_1$ increases proportionally with the temperature. (auth)

**29414** CRYSTAL FIELD SPLITTING IN $CaF_2:Nd^{3+}$. Zoltan J. Kiss (RCA Labs., Princeton, N. J.). J. Chem. Phys., 38: 1476-80(Apr. 1, 1963).

The crystal field split levels of the $^4I_{\frac{9}{2}}$ and $^4I_{\frac{11}{2}}$ states of $CaF_2:Nd^{3+}$ were determined from the fluorescence and absorption spectra. The data are compared to an energy-level calculation for the case of a weak cubic field containing fourth- and sixth-order terms. Both the absorption and fluorescence spectra were found to be strongly concentration dependent at relatively low concentrations (0.01 mole %). (auth)

**29415** ABSORPTION SPECTRUM OF GASEOUS $F^-$ AND ELECTRON AFFINITIES OF THE HALOGEN ATOMS. R. Stephen Berry and Curt W. Reimann (Yale Univ., New Haven). J. Chem. Phys., 38: 1540-3(Apr. 1, 1963).

The absorption spectrum of gaseous fluoride ion was observed in shock-heated vapors of CsF, RbF, and KF. The spectrum is a continuum with two sharp thresholds at 3595 and 3542 Å, similar to those of the other halide ions. The electron affinity determined from the low-energy threshold is 3.448 ± 0.005 ev. The cross section for photodetachment at 3565 Å is about $2.5 \pm 2 \times 10^{-18}$ cm$^2$ and at 3525, about $3.3 \pm 2 \times 10^{-18}$ cm$^2$. The electron affinities of chlorine, bromine and iodine are revised, respectively, to 3.613, 3.363, and 3.063 ev, all with uncertainties of 0.003 ev. (auth)

**29416** POTENTIAL-ENERGY CURVES OF THE EXCITED STATES OF ALKALI HYDRIDE MOLECULES. D. C. Jain and P. Sah (Banaras Hindu Univ., Varanasi, India). J. Chem. Phys., 38: 1553-7(Apr. 1, 1963).

The potential-energy curves of the excited states of NaH and KH were obtained by the Rydberg-Klein-Rees method as described by Singh and Jain. The simple-harmonic curves and ionic curves for LiH, NaH, KH, and RbH were also calculated. It was found that the potential-energy curves mostly agree with Mulliken's findings as to the anomalous behavior of the excited states of alkali hydrides. (auth)

**29417** SPIN-ORBIT SPLITTING OF THE F-CENTER BAND. Maciej Suffczynski (Univ. of Rochester, N. Y.). J. Chem. Phys., 38: 1558-61(Apr. 1, 1963).

Spin-orbit splitting of the first excited state of the F center is estimated in the simple effective-mass approximation. The splitting due to the outermost orbitals of the atoms neighboring the vacancy in the crystal is related to the splitting of the p state in the free atom. As an example, spin-orbit splitting of the F center in cesium halides is estimated. It is found to 4-to-6 orders of magnitude too small to account for the structure observed in the F-center absorption band in cesium halides. (auth)

**29418** GROUND STATE OF THE $HeH^+$ MOLECULE ION. Basil G. Anex (Indiana Univ., Bloomington) and Yale Univ., New Haven). J. Chem. Phys., 38: 1651-62 (Apr. 1, 1963).

Configuration interaction calculations were carried out for the system $HeH^+$ using one-electron basis functions in confocal elliptical coordinates. Four internuclear separations, R = 1.00, 1.40, 1.80, and 2.20 bohrs (B) were studied rather intensively. One of these, R = 1.40 B, lies very close to the equilibrium R and the energies found in this region represent the lowest thus far reported for $HeH^+$. Self-consistent field calculations were also made and in combination with the configuration interaction results lead to an estimation of correlation energies. The binding energy, the equilibrium internuclear separation, and the first few vibrational energies for the system were also estimated. The center of negative charge, which is closely related to the dipole moment, was studied as a function of R and of the size of the one-electron basis. (auth)

**29419** NEUTRON INELASTIC SCATTERING STUDIES OF GLOBULAR COMPOUNDS. L. N. Becka (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Chem. Phys., 38: 1685-8(Apr. 1, 1963).

The use of neutron inelastic scattering measurements to determine the nature of the solid-state transitions in globular compounds is proposed and exemplified. Patterns were taken of the high- and low-temperature phases of solid cyclohexane, 2-2-dimethylbutane, and 1-4-diazo-bicyclo-(2.2.2)-octane. The first two have broad inelastic scattering peaks in the low-temperature phase. In the high-temperature phase, these peaks disappear and the elastic peak broadens markedly. These changes are attributed to "quasi-free-rotation" of the molecules. Inelastic peaks do not appear in 1-4-diazo-bicyclo-(2.2.2)-octane, and the elastic peak does not broaden appreciably in the high-temperature phase. Self-diffusion coefficients $D_{\frac{1}{2}} = 4.5 \times 10^{-5}$ cm$^2$/sec for cyclohexane and $D_{\frac{1}{2}} = 8.6 \times 10^{-5}$ cm$^2$/sec for 2-2-dimethylbutane were determined from the patterns of the liquids at 300°K using the "small motions" approxi-

mation. These values are larger than those obtained from NMR measurements, presumably as a result of irreversible rotation of the molecules. (auth)

**29420** $Fe^{57}$ MÖSSBAUER EFFECT IN FERROCENE DERIVATIVES. G. K. Wertheim (Bell Telephone Labs., Inc., Murray Hill, N. J.) and R. H. Herber. J. Chem. Phys., 38: 2106-11(May 1, 1963).

The hyperfine structure in the Mössbauer spectrum of $Fe^{57}$ in ferrocene and in related compounds shows that the bonding of the iron atom is not affected by ring substitution. The temperature dependence of the fraction of recoil-free absorption events in these compounds indicates that the Debye temperature is low (~150°K) and that the optical modes make only a minor contribution to the reduction of the recoil-free fraction at low temperature. (auth)

**29421** ITERATIVE METHOD FOR SOLUTION OF THE ONE-DIMENSIONAL WAVE EQUATION: EIGENVALUES AND EIGENFUNCTIONS FOR L-J (12,6) AND EXPONENTIAL ($\alpha$,6) INTERATOMIC POTENTIALS. Halstead Harrison and Richard B. Bernstein (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 38: 2135-43(May 1, 1963). (TID-17984)

A method of direct numerical integration of the one-dimensional wave equation is described and illustrated by calculations of the radial wavefunctions, vibrational energy levels, and numbers of bound states for diatomic molecules. Within the validity of the Born–Oppenheimer approximation, the procedure yields arbitrarily accurate eigenvalues. Several potentials involving long-range, inverse-sixth-power attractions are examined. Results are compared with those from the first-order WKBJ integral and with the Dunham form of the second-order WKBJ approximation. (auth)

**29422** STRUCTURE OF THE $f^6$ CONFIGURATION WITH APPLICATION TO RARE-EARTH IONS. G. S. Ofelt (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 38: 2171-80(May 1, 1963).

Free-ion energy-level schemes for the $4f^6$ and $4f^8$ configurations of $Eu^{3+}$, $Sm^{2+}$, and $Tb^{3+}$ are given, which were calculated from energy matrices including interactions among the three highest multiplicities. The values obtained for the parameters are $F_2 = 401\ cm^{-1}$, $\zeta = 1320\ cm^{-1}$ for $Eu^{3+}$; $F_2 = 330\ cm^{-1}$, $\zeta = 1050\ cm^{-1}$ for $Sm^{2+}$; and $F_2 = 434\ cm^{-1}$, $\zeta = 1705\ cm^{-1}$ for $Tb^{3+}$. The wavefunctions and g values for levels to 40,000 $cm^{-1}$ are tabulated for $Eu^{3+}$ and $Tb^{3+}$. Application of the free-ion wavefunctions to the Stark splitting of $EuCl_3$ and $TbCl_3$ is discussed. (auth)

**29423** ENERGY LEVELS OF $Tb^{3+}$ IN $LaCl_3$ AND OTHER CHLORIDES. K. S. Thomas, S. Singh, and G. H. Dieke (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 38: 2180-90(May 1, 1963).

The absorption and fluorescence spectra of $Tb^{3+}$ in $LaCl_3$ were used to find the levels of $Tb^{3+}$. All Stark components of $^7F$ and $^5D_4$ were unambiguously established. The classification of the higher levels is still doubtful. The analysis was helped by Zeeman effects and particularly crystal field calculations. The latter gave as crystal field parameters: $B_2^0 = 92$, $B_4^0 = -40$, $B_6^0 = -30$, $B_6^6 = 290\ cm^{-1}$. $Tb^{3+}$ in $YCl_3$ has a similar spectrum but, because of different crystal symmetry, with different fine structure. A third type of spectrum is obtained from pure $TbCl_3$. (auth)

**29424** SPECTRA AND ENERGY LEVELS OF $Eu^{3+}$ IN $LaCl_3$. L. G. DeShazer and G. H. Dieke (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 38: 2190-9(May 1, 1963).

The absorption and fluorescence spectra of $Eu^{3+}$ in $LaCl_3$ were obtained and analyzed. Crystal-field calculations give good agreement with the observed Stark components for $B_2^0 = A_2^0\langle r^2\rangle = 89\ cm^{-1}$, $B_4^0 = -38\ cm^{-1}$, $B_6^0 = -51\ cm^{-1}$, and $B_6^6 = 495\ cm^{-1}$. (auth)

**29425** KINETICS OF THERMAL IONIZATION. II. XENON AND KRYPTON. Wade M. Kornegay and Harold S. Johnston (Univ. of California, Berkeley). J. Chem. Phys., 38: 2242-7(May 1, 1963).

The rate and mechanism of the thermal ionization of xenon were further studied by a microwave and shock-tube method. The negligible effect of impurities or background on the observed ionization rates was demonstrated. For a variety of added gases, the activation energy for the observed ionization was about 8 ev, not 12.1 ev, the ionization energy. Detailed time studies show an induction period for buildup of free electrons as a result of populating intermediate electronic states of xenon; however, the simple three-step mechanism proposed previously ($Xe + M \rightleftharpoons Xe^* + M$, $Xe^* + M \rightarrow Xe^+ + e^- + M$) was shown to be insufficient to explain certain quantitative features of the data. At these high temperatures a large number of parallel paths are possible, and in general, entropy differences are more important than energy differences. On this basis it is argued that the final ionization process leads to $Xe^+ + e^- + M$ and not $MXe^+ + e^-$. Limited data are presented on the ionization of krypton, and an activation energy of about 10 ev, not 14 ev (the ionization energy), is indicated. Reaction cross sections are given for xenon and krypton. (auth)

**29426** CHARGE TRANSFER IN OXYGEN, NITROGEN, AND NITRIC OXIDE. R. F. Stebbings, Ben R. Turner, and A. C. H. Smith (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Chem. Phys., 38: 2277-9 (May 1, 1963).

The cross sections for charge transfer in collisions of $N_2$ and $O_2$ with various atomic and molecular ions were measured within the energy range 30 to 10,000 ev. Modulated-crossed-beam techniques were used and the relative cross sections so obtained were normalized with the aid of absolute measurements made by Stier and Barnett. Some measurements of charge transfer in NO are also reported. (auth)

**29427** CHARGE TRANSFER BETWEEN SOME ATMOSPHERIC IONS AND ATOMIC OXYGEN. R. F. Stebbings (General Atomic Div., General Dynamics Corp., San Diego, Calif.), A. C. H. Smith, and H. B. Gilbody. J. Chem. Phys., 38: 2280-4(May 1, 1963).

Cross sections for charge transfer between oxygen atoms and $N^+$, $N_2^+$, $NO^+$, and $O_2^+$ ions were measured within the energy range 50 to 10,000 ev, using modulated-crossed-beam techniques. The neutral beam effused from a Pyrex tube in which an electrodeless r-f discharge could be established. It was determined, by use of a mass spectrometer, that about 40% of the molecules in the beam could be dissociated. The currents of slow ions which resulted from charge transfer between the primary ion beam and both the undissociated and partially dissociated oxygen beams were measured. The atomic cross sections were then evaluated from knowledge of these currents, the dissociation, and the previously determined molecular charge-transfer cross sections. (auth)

**29428** IONIZATION BY IONS IN THE Mev RANGE. S. Wexler and D. C. Hess (Argonne National Lab., Ill.). J. Chem. Phys., 38: 2308-9(May 1, 1963). (TID-17879; UAC-7088)

Acetylene was bombarded with 2.25-Mev protons, and the resulting slow positive ions were analyzed using a

mass spectrometer. The fragmentation intensity pattern relative to m/e = 26 is as follows: 100 for m/e = 26; 30 ± 3 for m/e = 25; 6.9 ± 0.5 for m/e = 24; 4.7 ± 0.4 for m/e = 13; and 2.6 ± 0.2 for m/e = 12. (D.L.C.)

**29429** UNUSUAL SPIN-SPIN COUPLINGS IN NMR SPECTRA OF ALKYL AMMONIUM SALTS. E. Bullock, D. G. Tuck, and E. J. Woodhouse (Univ. of Nottingham, Eng.). J. Chem. Phys., 38: 2318(May 1, 1963).

The NMR spectrum of tetraethylammonium iodide in $D_2O$ has quartet signals at 1.37 ppm and triplet signals split into 1 : 1 : 1 triplets at 3.42 ppm. This splitting is attributed to coupling with $N^{14}$. (D.L.C.)

**29430** KINETIC THEORY OF NONSPHERICAL MOLECULES. [PART] V. C. F. Curtiss (Univ. of Wisconsin, Madison) and J. S. Dahler. J. Chem. Phys., 38: 2352-62 (May 15, 1963).

A generalized Boltzmann equation for fluids composed of molecules with arbitrary internal degrees of freedom and which interact according to classical mechanics through arbitrary, noncentral pair-additive forces is developed using techniques similar to those used by Hollinger and Curtiss. Several special cases are considered: (1) molecules which interact only through impulsive forces of repulsion, (2) molecules for which the only internal degrees of freedom are rotational degrees, and (3) a combination of both special cases. The third special case leads to a Boltzmann equation appropriate to a fluid composed of rigid nonspherical molecules, and provides a firm basis upon which to develop a formal kinetic theory. As a special example, a gas made up of rigid, convex, nonspherical molecules with symmetric-top mass distributions is considered. Rigorous equations of hydrodynamics are presented for such a fluid. It is shown that the kinetic theory of a dilute multicomponent system of these molecules is formally the same as that for the loaded-sphere system recently studied by Dahler and Sather. Finally, it is shown how the methods developed by these authors can be applied to the problems of solving the Boltzmann equation and of calculating the transport coefficients for the nonspherical molecular species considered in the present paper. (auth)

**29431** KINETIC THEORY OF LOADED SPHERES. PART I. John S. Dahler and Norman F. Sather (Univ. of Minnesota, Minneapolis). J. Chem. Phys., 38: 2363-82 (May 15, 1963).

A rigorous formalism is developed for the theory of transport in fluids composed of loaded-sphere molecules. Form this theory formulas are derived for the fluxes of mass, linear momentum, internal or spin angular momentum, and energy. The existence of inverse collisions is established and used to prove a weak form of the Boltzmann H theorem. Finally, a kinetic theory is presented for dilute multicomponent mixtures of loaded spheres and explicit formulas are derived for the phenomenological gas transport coefficients. Since the only critical assumption imbedded within this treatment is that of molecular chaos, it appears that the theory for loaded spheres shares the "rigor" of the Chapman-Enskog theory for structureless molecular species. (auth)

**29432** MOLECULAR ORBITALS FOR $H_2$ BASED ON CENTRAL POTENTIALS. AVERAGE HAMILTONIAN AND CORRELATION ENERGY. James M. Peek and Edwin N. Lassettre (Ohio State Univ., Columbus). J. Chem. Phys., 38: 2382-91(May 15, 1963).

The exact Hamiltonian for $H_2$ is averaged over trial functions composed of molecular orbitals which are defined by a model suggested by the authors [J. Chem. Phys. 33: 1803 (1960)]. The three trial functions studied are (a) the single configuration type, (b) a two-configuration type including the $\sigma_u$ orbital defined by the model, and (c) a function composed of a product of the lowest $\sigma_g$ orbitals multiplied by a correlation function including one term having $\sigma_u$ symmetry. The results from the single configuration function indicate that the lowest $\sigma_g$ molecular orbital is a good approximation to an SCF orbital. The configuration interaction (CI) calculation indicates that a CI expansion based on these orbitals will converge very slowly to an eigenfunction of $H_2$. Adding a one-term correlation function gave significant improvement, and the construction of a more complicated correlation function, by means of the variation principle, would undoubtedly lead to a good approximation to the exact eigenfunction. Rather than proceed along these lines, analysis of the various average values contributing to the total energy and the corresponding values predicted by the model suggests a different approach. It is found that, at the equilibrium internuclear distance, potential energy terms computed from the model agree with the exact values much better than average values based on the three trial functions, while the kinetic energy is much more poorly represented. This indicates that calculation of the total energy from the potential energy by the virial theorem would give better results than using the less exact kinetic energy term to construct the total energy and, at the same time, provide a means of calculating the total energy without knowledge of the correlation function. A constraint on the average of the exact Hamiltonian is introduced to provide a rigorous foundation for the above observation, and an appropriately modified virial equation is derived. An approximate solution of this equation is investigated. It is found that a complete solution is not possible without knowledge of the exact energy at one point. (auth)

**29433** CORRELATION DIAGRAM FOR $H_2$. OSCILLATOR STRENGTHS. James M. Peek and Edwin N. Lassettre (Ohio State Univ., Columbus). J. Chem. Phys., 38: 2392-4(May 15, 1963).

The eigenvalues of a one-electron Hamiltonian, based on a model of the hydrogen molecule proposed earlier by the authors [J. Chem. Phys. 33: 1803 (1960)], were calculated for several states as a function of internuclear distance. These results are shown as a correlation diagram which is complete for all states correlating with separated atoms having principal quantum numbers up to three. This correlation diagram provides a semiquantitative justification for the model. A number of physical implications of the diagram are discussed. Several members of the set of one-electron eigenfunctions of the model Hamiltonian were used to calculate oscillator strengths for single electron excitations. The values 0.28, 0.556 were found for the oscillator strengths corresponding to the Lyman and sum of the Lyman and Werner bands, where the best available estimates for $H_2$ are 0.27, 0.65, respectively. A number of other oscillator strengths, for which there is no available information for comparison, were also calculated. (auth)

**29434** ONE-ELECTRON POTENTIAL FUNCTION FOR $H_2$. Edwin N. Lassettre and James M. Peek (Ohio State Univ., Columbus). J. Chem. Phys., 38: 2395-9(May 15, 1963).

A one-electron potential function is shown to exist such that the exact energy of the hydrogen molecule can be calculated with only a knowledge of the solution to the one-electron Schrödinger equation, its eigenvalue, and an average, over this solution, of the potential energy of one electron in the mean field of the remaining electron. Hence,

given this potential function in advance, the exact energy of $H_2$ can be calculated from the solution of a one-electron problem. A formula for this potential function is obtained in terms of the exact eigenfunction for $H_2$. The formula can only be applied to accurately calculate the potential function when the hydrogen eigenfunction is known, and hence the formula is useful primarily to demonstrate the existence of the potential. On the basis of the Heitler-London wavefunction, an approximate numerical comparison between this potential function and that suggested by Slater is given. An empirical formula for the potential function is suggested, and an undetermined parameter is obtained using an approximate eigenfunction. (auth)

**29435** MODIFICATION OF THE BORN-MAYER POTENTIAL FUNCTION AS APPLIED TO THE CRYSTALLINE ALKALI HALIDES. Thomas B. Douglas (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 38: 2461-6(May 15, 1963).

The repulsion constant $\rho$ in the Born-Mayer potential function is assigned values which are different for like- and unlike-ion pairs in such a way that large deviations from the observed compressibilities of the lithium halides, attributable to marked anion–anion repulsion, are removed. Lattice parameters in excellent agreement with the experimental ones are then obtained using alternative sets of "basic radii" based on differently evaluated ionic radii, but an indeterminacy characteristic of the Born-Mayer equation is shown to affect markedly the calculated like-ion overlap-repulsive contributions. The possibility of considerable error in the calculated results through lack of correction for ion asymmetry is discussed. The calculated electron affinities, which are unaffected by these uncertainties, agree approximately with the most precise determinations by other methods. (auth)

**29436** NUCLEAR MAGNETIC RESONANCE IN POLYCRYSTALLINE $UF_6$. R. Blinc (Nuclear Institute "Jozef Stefan," Ljubljana, Yugoslavia), V. Marinković, E. Pirkmajer, I. Zupančič, and S. Maričič. J. Chem. Phys., 38: 2474-7(May 15, 1963).

An $F^{19}$ magnetic resonance study of polycrystalline uranium hexafluoride as a function of temperature and magnetic field is presented. The low temperature spectra are resolvable into two symmetric components, demonstrating the existence of two nonequivalent sets of U–F bonds. At higher temperatures the two resonances coalesce in spite of the fact that the magnetic susceptibility of $UF_6$ is temperature independent. The possible origin of this effect is discussed. (auth)

**29437** FCC ELASTIC CONSTANTS FOR ARBITRARY CENTRAL FORCES BY THE METHOD OF LONG WAVES. William C. Overton, Jr. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 38: 2482-93(May 15, 1963). (LADC-5582)

Assuming a central-force pair potential of arbitrary form, the secular equation for the vibrations of a face-centered cubic lattice is derived for interactions through 23rd neighbors (the 682 nearest neighbors). An elementary treatment of all forces arising because of atom displacements shows that the first derivative of the potential inevitably enters as a force constant in the diagonal elements of the secular determinant in addition to the usual second derivative constants. The long-wave limiting case of [100] and [110] directions leads to sets of lattice sums, combinations of which give the elastic constants. The derived $(c_{11} + 2c_{12})/3$ is found to be the same as the bulk modulus derived independently from the static lattice potential energy, an internally consistent result not ordinarily obtained by the method of long waves. The lattice sums obtained are recast and evaluated for the $-Ar^{-m} + Br^{-n}$ potential by averaging the sums through 23rd neighbors (corrected by integration to $\infty$) with those through 22nd neighbors (corrected by integration to $\infty$). Tests indicate high accuracy for the averaged results. The Cauchy relation $c_{12} = c_{44}$ is found not to be obeyed unless various known volume forces are assumed absent. In empirical application to copper at 0°K a 4–7 potential (with minimum closer than nearest neighbors) is found to give experimental $c_{44}$ and $C' = (c_{11} - c_{12})/2$, correctly, $(\partial c_{44}/\partial p)$ within 10%, but with $(\partial C'/\partial p)$ off by a factor or 4. Other m–n potentials were also unable to give these experimental copper parameters properly. Applications to solid $He^3$ and $He^4$ are also considered. (auth)

**29438** BOUNDARY EFFECT CORRECTIONS FOR THE THOMAS-FERMI ATOMIC INTERACTION POTENTIAL. J. R. Townsend and J. M. Keller (Univ. of Pittsburgh). J. Chem. Phys., 38: 2399-2506(May 15, 1963).

The electronic energies of a neutral diatomic molecule with noninteracting electrons are calculated by two methods: first, using solutions of Schrödinger's equation for a hydrogenlike molecular ion; second, using the assumption of a slowly varying potential, characteristic of the Thomas-Fermi (TF) method. Comparison of these solutions serves both as a test of the TF method and as a means of correcting partially for the TF shortcomings. Based on the success of this method as applied by Scott to the TF atom, the corrected interaction energy is believed correct to within 20% for separations up to $Z^{-1/3}$ Å. Of qualitative interest is the prediction of bound molecules at large separations except for the rare gases which remain repulsive. (auth)

**29439** COMPARISON AND APPRAISAL OF APPROXIMATION FORMULAS FOR TOTAL ELASTIC MOLECULAR SCATTERING CROSS SECTIONS. R. B. Bernstein and K. H. Kramer (Univ. of Michigan, Ann Arbor and Univ. of Wisconsin, Madison). J. Chem. Phys., 38: 2507-11(May 15, 1963). (TID-17976)

The Massey-Mohr (MM), Schiff (S), and Landau-Lifshitz (LL) approximations for the total elastic cross section (Q) are intercompared. All can be shown to follow from the same assumption, (i.e., the classical small-angle deflection function, thence the Jeffreys-Born phases via the semi-classical equivalence relationship), sufficing to determine the velocity dependence of Q. Thus, for $V = \pm C^s/r^s$, $Q^s = p(s)\,[C^s/\hbar v]^{2/s-1}$. The coefficient p(s) is the same for the S and LL approximations; the ratio $p_{SLL}(s)/p_{MM}(s) \geq 1$, (<1.075); it is 1.0709 and 1.0458 for s = 6 and 12, respectively. A numerical calculation for a repulsive (s = 12) interaction shows that the SLL formula reproduces the partial-wave calculated Q to within ½%. A graphical presentation suggests the generality of this result; it also indicates the source of bias in the MM approximation. For a "realistic" intermolecular potential, (restricting consideration to collisions in the "thermal" energy range), the influence of the repulsion is only to produce undulations in Q(v); the correct value of $C^6$ may be obtained by velocity averaging the "apparent" $C_{SLL}^6$. (auth)

**29440** MULTISTAGE RADIATIVE TRANSITIONS IN $CaF_2:Er^{3+}$. S. A. Pollack (Space Technology Labs., Inc., Redondo Beach, Calif.). J. Chem. Phys., 38: 2521-9 (May 15, 1963).

The theory of multistage transitions is reviewed. A brief account of the fluorescence spectrum of $CaF_2:Er^{3+}$ 0.1% concentration of $Er^{3+}$ ion per mole is given. The principal regions of excitation are around 2550 and 3750

Å, which produce basically different spectra. The fluorescence groups excited with 2550-Å monochromatic radiation are tabulated. Most of the groups are found to be parts of multistage radiative relaxation processes. The stages of these mostly two-stage processes are identified, and the decay curves of two-stage transitions are analyzed. The nonexponential decay curves of the second-stage transitions are resolved into the difference of two exponentials, and the time constants are determined. The agreement with the time constants obtained for the first and the second stages excited separately is satisfactory. The occurrences of the maxima of the decay curves for the second-stage transitions are in agreement with calculations. The temperature and concentration dependence of the transition probabilities is investigated. The decay curves for transitions excited with several wavelengths are analyzed. All experimental results are accountable by the theory. (auth)

**29441** INTERACTION OF LOW-ENERGY ELECTRONS WITH WATER VAPOR AND WITH OTHER POLAR MOLECULES. G. S. Hurst, J. A. Stockdale, and L. B. O'Kelly (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 38: 2572-8(May 15, 1963).

Electron attachment coefficients and drift velocities were measured in mixtures of $H_2O$ vapor with $N_2$, $CH_4$, $C_2H_4$, and $CO_2$. Electron capture takes place only in the $H_2O$–$CO_2$ mixture, and even in this case the attachment coefficient is quite small. Thus, low-energy (less than 1 ev) electrons do not, in general, form stable negative ions with $H_2O$. Electron drift velocities are very sensitive to the addition of small quantities of $H_2O$ vapor in all the mixtures. When certain other polar molecules (acetone, heavy water, methyl alcohol, dimethyl ether, hydrogen sulfide, toluene, and nitrous oxide) were mixed with $C_2H_4$, it was found that the decreases in drift velocity correlated well with the magnitude of the electrical dipole moments. The drift velocity data were analyzed to obtain the cross sections for momentum transfer. These cross sections are in fair agreement with the theory of Altshuler, except for $H_2O$, $D_2O$, and $H_2S$, where the experimental values are a factor of 2 larger than theory. This discrepancy may be due to molecular rotational enhancement of the momentum transfer cross section, or it may be due to the temporary formation of negative ions, an effect which would decrease the observed drift velocity. (auth)

**29442** CONSTANTS FOR A (6-exp) POTENTIAL BETWEEN SIMPLE MOLECULES AND GRAPHITE. A. D. Crowell and Chai-ok Chang (Univ. of Vermont, Burlington). J. Chem. Phys., 38: 2584-6(May 15, 1963).

If the interaction between a gas molecule and an individual C atom in graphite is expressed as $u(r) = -Ar^{-6} + B \exp(-\alpha r)$, then the total energy of interaction becomes $\phi(z) = -(A\pi\sigma/12\, d^4)\psi^{(3)}(x) + B[2\pi\sigma/\alpha^2]\,(\alpha z + 1)e^{-\alpha z}$. The values for the constants A, B, and $\alpha$ were calculated from empirical constants for (6-exp) interactions between like molecules and atoms. The values were used to evaluate $z_0$ and $\phi(z_0)$, and the internal energies at 0°K are compared with experimental values of Sams for five gases. It is concluded that the (6-exp) potential is as satisfactory as the (6-12) potential. (D.L.C.)

**29443** IONIZATION BY ALPHA PARTICLES IN BINARY GAS MIXTURES. T. D. Strickler (Oak Ridge National Lab., Tenn. and Berea Coll., Ky.). J. Phys. Chem., 67: 825-30(Apr. 1963).

The W value (average energy loss per ion pair) for $\alpha$ particles was measured in a number of binary gas mixtures of molecular gases as a function of the fractional pressures. The W of the mixture ($W_{ij}$) can be represented in terms of the W's of the pure constituent gases ($W_i$, $W_j$) and the fractional pressures ($P_i$, $P_j$) by the relation: $W_{ij} = (W_i - W_j) \cdot Z_{ij}'' + W_j$, where $Z_{ij}'' = P_i/(P_i + f_{ij}P_j)$, in which $f_{ij}$ is a constant determined empirically for each pair of gases. These constants very nearly satisfy the relationship $f_{ij} = f_j/f_i = (f_j/f_k)/(f_i/f_k) = f_{kj}/f_{ki}$, where i, j, and k refer to any three gases. Thus, if the following f-values are assigned to the gases in this study ($N_2$, 1; $CO_2$, 1.8; $H_2$, 0.5; $O_2$, 1.3; $CH_4$, 1.8; $C_2H_4$, 3.4; $C_2H_6$, 3.5; $C_3H_6$, 4.5; $C_3H_8$, 4.5; $C_4H_8$, 6.3) then the constant $f_{ij}$ determined from the ratio of any two of these will serve to predict the W of any mixture of these two gases with an accuracy better than 1%. Slight departures from the W predicted by the above equation were noted in the case of nitrogen mixtures, indicative of an effect similar to that observed in the noble gases when small amounts of impurities are added. (auth)

**29444** INDUCED CONDUCTIVITY IN CADMIUM SELENIDE BY ELECTRON BOMBARDMENT. H. W. Sturner and C. E. Bleil (General Motors Corp., Warren, Mich.). J. Phys. Chem. Solids, 24: 735-9(June 1963). (In English)

The effects of generated x radiation on induced conductivity in cadmium selenide under electron bombardment shows that cadmium selenide and cadmium sulfide behave in much the same manner. The specific role of certain x radiations is more evident for cadmium selenide than for cadmium sulfide. On the other hand, no measure of the exciton diffusion length was possible for cadmium selenide. (auth)

**29445** AN INVESTIGATION OF THE ENERGY LEVELS IN ALKALINE EARTH HYDROXIDES BY INELASTIC SCATTERING OF SLOW NEUTRONS. George Safford, Velko Brajovic, and Henri Boutin (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem. Solids, 24: 771-7(June 1963). (BNL-6460)

The Brookhaven slow chopper was used to study the differential inelastic cross section for 5-Mev incident neutrons scattered at 90° from polycrystalline samples of $Mg(OH)_2$ and $Ca(OH)_2$. In the energy interval covered (3 to 163 Mev) corresponding to wave numbers of 25 to 1300 $cm^{-1}$, four distinct peaks were observed in both compounds at 293°K. They occur at 633 ± 30 $cm^{-1}$ (A), 377 ± 8 $cm^{-1}$ (B), 281 ± 9 $cm^{-1}$ (C), 135 ± 10 $cm^{-1}$ (D), respectively, in $Mg(OH)_2$ and at 540 ± 30 $cm^{-1}$ (A), 316 ± 7 $cm^{-1}$ (B), 247 ± 15 $cm^{-1}$ (C), and 83 ± 7 $cm^{-1}$ (D) in $Ca(OH)_2$. A spectrum taken at 103°K for $Mg(OH)_2$ shows that peaks A, B, and C appear unshifted in energy while D increases in intensity relative to A, B, and C and appears at 120 ± 7 $cm^{-1}$. The intensities of the individual peaks in $Mg(OH)_2$ are observed to vary with temperature in accordance with the temperature dependence of one-phonon differential scattering cross section, if $\Theta_{Debye} \gg T$ is assumed. The low-energy peaks D in both $Mg(OH)_2$ and $Ca(OH)_2$ are too broad to be due to a single transition and have shapes characteristic of an acoustic branch of normal mode. It is shown that the observed spectrum cannot be explained by a highly localized rotational motion of the $OH^-$ ions, as suggested by Hexter and some of the transitions observed are in qualitative agreement with an interpretation in terms of low-frequency lattice modes of the crystal. (auth)

**29446** SCATTERING OF COLD NEUTRONS IN BERYLLIUM OXIDE. P. G. Khubchandani and S. Sanatani (Atomic Energy Establishment, Trombay, India). J. Phys. Chem. Solids, 24: 782-4(June 1963). (In English)

It is shown that the incoherent approximation is not valid for the scattering cross section of cold neutrons in poly-

crystalline BeO. The more rigorous coherent approximation is used to calculate the one-phonon contribution to scattering for neutron wavelengths 5, 5.5, and 6 A, and BeO temperatures of 100, 200, 300, and 400°K. Two-phonon cross sections are also calculated for 300 and 400°K. The calculated results are compared with Begum's experimental data on a cross section vs temperature graph. (D.L.C.)

**29447** MEASUREMENT OF RELATIVISTIC TIME DILATATION USING THE MOSSBAUER EFFECT. D. C. Champeney, G. R. Isaak, and A. M. Khan (Univ. of Birmingham, Eng.). Nature, 198: 1186-7(June 22, 1963).

Mössbauer experiments are described in which relative frequency-shift effects of up to 24% were observed. A $Co^{57}$ source diffused into a $Fe^{56}$ foil is mounted at the center of a hollow rotor with a $Fe^{57}$ absorber foil at one end, and the rotor was rotated at varying speeds. Measurements were also made by moving the absorber slowly toward the source at a uniform velocity v. The rotor transmission curve as a function of rotor speed was found to be represented well by a Lorentzian line shape from the slow-motion device, $v = K(v_4^2 - v_3^2)/2c$, with K equal to unity. The experimental results gave $K = 1.03 \pm 0.03$, with a positive sign. (D.L.C.)

**29448** GYROMAGNETIC RATIO OF THE PROTON. P. Vigoureux (National Physical Lab., Teddington, Middx., Eng.). Nature, 198: 1188(June 22, 1963).

A determination of the unit of electric current was made which enables the gyromagnetic ratio of the proton to be referred to the ampere. The revised ratio of the proton in water, uncorrected for diamagnetism, is $2.67513 \times 10^8$ $Wb^{-1}$ $m^2$ $sec^{-1}$ with a total probable error of 5 in $10^6$. (D.L.C.)

**29449** PARTICULAR SOLUTION OF EINSTEIN'S FIELD EQUATIONS. K. Chandra Shekhar (Asfa Wossen School, Addis Ababa, Ethiopia). Nuovo Cimento (10), 28: 902-7(June 1, 1963). (In English)

The further effect of the remaining field equations on the solution of the first two field equations of Einstein's set under the λ-conditions that give rise to the constant values of the scalar K in the second class space-time were considered. (auth)

**29450** MASS-SPECTROSCOPIC ATOMIC MASS DIFFERENCES. V. B. Bhanot and S. C. Gupta (Panjab Univ., Chandigarh, India). Nuovo Cimento (10), 28: 1011-23(June 1, 1963). (In English)

New mass-spectroscopic data on atomic mass differences in the medium and heavy mass regions were compiled and tabulated. Corresponding values in the new scale based on $C^{12}$ as the standard are also given. Unadjusted experimental values for nuclidic masses in the new scale were listed. For a large number of stable nuclides in the region from strontium to antimony the newer values obtained from the data of Demirkhanov et al., are more accurate than the corresponding values listed in the recent exhaustive mass table of König et al. Attention is drawn to the advantages of the isotopic doublets over the published conventional mass doublets in the heavy mass region. (auth)

**29451** THE ACOUSTIC IMPEDANCE OF LIQUID $He^3$ AND ZERO SOUND. B. E. Keen, P. W. Matthews, and J. Wilks (Clarendon Lab., Oxford). Phys. Letters, 5: 5-6(June 1, 1963). (In English)

The reflection coefficient for a 1000 Mc/sec sound wave in quartz incident on an interface with liquid He was measured using a quartz crystal with its end projecting into a microwave cavity. Reflections of pulses introduced into the crystal were observed by the microwave pulses generated. Measurements on the relation between acoustic impedance, velocity of sound, and fluid density for $He^3$ and $He^4$ at temperatures down to 0.04°K revealed behavior in $He^3$ that apparently resulted from transition from ordinary to zero sound. (D.C.W.)

**29452** SHAPE RESONANCES IN SUPERCONDUCTORS. II. SIMPLIFIED THEORY. C. J. Thompson and J. M. Blatt (Univ. of New South Wales, Kensington, Australia). Phys. Letters, 5: 6-9(June 1, 1963). (In English)

An analytic calculation on the chemical potential as a function of film thickness and on the energy gap parameter for a superconducting uniform medium is presented. The chemical potential is noted to have a secular rise as the slab is made narrower. Asymptotic expressions for the energy gap go to unity for large slab thicknesses, the excess being inversely proportional to the thickness. The asymptotic form of the resonance width for large slab thickness is directly proportional to $\hbar\omega_c$. (D.C.W.)

**29453** THE CRITICAL CURRENT OF A SUPERCONDUCTOR OF THE SECOND KIND. R. A. Kamper (C.E.R.L., Leatherhead, Surrey, Eng.). Phys. Letters, 5: 9-10(June 1, 1963). (In English)

It was demonstrated that a superconductor with a negative interphase surface energy can not carry a net current in the presence of an external magnetic field sufficiently strong to penetrate the interior and create the "mixed state" without the aid of structural imperfections to stabilize the current against the Lorentz force. Measurements on the persistent current induced in a ring-shaped specimen (In–Pb) of circular cross section by a rising magnetic field confirmed the $H - I_c$ relation necessary for this situation. (auth)

**29454** MAGNETIC TRANSITION OF A SUPERCONDUCTING FILM IN A TRANSVERSE FIELD. G. K. Chang, T. Kinsel, and B. Serin (Rutgers Univ., New Brunswick, N. J.). Phys. Letters, 5: 11-13(June 1, 1963). (In English)

Magnetization curves obtained for tin films of 850 and 2600 Å thickness confirm the predictions of Tinkham's theory of the transition of a superconducting film in a perpendicular magnetic field. Experimental values for the field at a second order transition agreed very well with predicted values and supported the supposition that the field values needed to restore the normal resistivity must be halved to get agreement with the theoretical expression. The magnetic behavior of the specimen was also found to be irreversible. (D.C.W.)

**29455** ALTERNATING CURRENTS IN SUPERCONDUCTORS. P. Graneau (BICC Research Organization, London). Phys. Letters, 5: 15-16(June 1, 1963). (In English)

The theory of normal conductors, when extrapolated to very high conductivities, is shown to predict an alternating current strangulation due to classical electromagnetic interactions. This, perhaps, accounts for the experimental failure of superconducting wires to transmit appreciable a-c electrical energy over distances. (D.C.W.)

**29456** THE TEMPERATURE DEPENDENCE OF THE UPPER CRITICAL FIELD IN SOME NIOBIUM SOLID SOLUTION ALLOYS. B. S. Chandrasekhar, J. K. Hulm, and C. K. Jones (Westinghouse Research Corp., Pittsburgh). Phys. Letters, 5: 18-20(June 1, 1963). (In English)

The temperature dependence of the upper critical magnetic field that determines the upper boundary of the mixed state in Nb–Ta and Nb–Ti alloys was investigated. The upper critical field was found to vary almost linearly with

temperature from $T_c$ down to about 0.3 $T_c$. At lower temperatures it flattens out rather rapidly. The relation between the upper critical field and the bulk thermodynamic critical field was also examined. (D.C.W.)

**29457** SUPERCONDUCTIVE TRANSITION OF ALUMINIUM CONTAINING TRANSITION METAL IMPURITIES. G. Boato, G. Gallinaro, and C. Rizzuto (Università, Genoa). Phys. Letters, 5: 20-1(June 1, 1963). (In English)

The effect of transition metal impurities on the critical temperature of superconducting non-transition metals was examined by critical temperature measurements on samples of pure Al containing traces of Cr, Fe, and Mn. A noticeable depression of the critical temperature was observed, and a nonlinear dependence of the critical temperature on the residual resistivity ratio was noted. Mean-free-path effects and scattering are believed to contribute to the depression. (D.C.W.)

**29458** SELF-CONSISTENT CALCULATION OF THE JOSEPHSON CURRENT. P. G. De Gennes (Faculté des Sciences, Orsay, France). Phys. Letters, 5: 22-4(June 1, 1963). (In English)

The boundary conditions imposed on the Landau-Ginzburg equation by the presence of a tunneling junction separating two identical superconductors are derived. The conditions are used to derive the current crossing the junction. Generalization of the method for the presence of a magnetic field is also considered. The derivations provide a link between the Gorkov self-consistency equations for the pairing potential and the superfluid tunneling current at zero voltage predicted by Josephson. (D.C.W.)

**29459** THE ANISOTROPHY OF THE FORBIDDEN BAND IN SUPERCONDUCTING ALUMINUM ALLOYS. R. Geiser and B. B. Goodman (Centre de Recherches sur les Très Basses Températures, Grenoble, France). Phys. Letters, 5: 30-2(June 1, 1963). (In French)

For certain superconductors the curve representing $\ln(C_{es}/\gamma T_c)$ as a function of $T_c/T = t^{-1}$ shows a net positive curvature for $t^{-1} > 4$. $C_{es}$ is the electronic specific heat in the superconducting state at temperature T; $\gamma$ is the coefficient of the normal electronic specific heat; and $T_c$ is the transition temperature. The curve is attributed to anisotropy of the forbidden band $\xi_0$, and measurements on Al containing impurities show that this anisotropy diminishes with $l/\xi_0$, where l is the mean free path of electrons in the normal state and $\xi_0$ is the length of coherence of the pure superconductor. The observed diminution agrees with theoretical predictions. (D.C.W.)

**29460** A VAN DE GRAAFF BEAM AS A SOURCE OF ATOMIC EMISSION SPECTRA. L. Kay (Univ. of Manchester, Eng.). Phys. Letters, 5: 36-7(June 1, 1963). (In English)

Both distinct and faint emission lines were observed when Ne and N beams from a Van de Graaff accelerator were passed through a carbon foil and imaged on a Raman spectrograph. The lines did not appear when the foil was removed, suggesting that the lines were emitted by atoms in the beams excited by atomic collisions in the carbon foils. Advantages and limitations of the device as a source of emission spectra are pointed out. (D.C.W.)

**29461** ON THE SPECTRAL LINE SHAPE OF A LASER BEAM. H. Z. Cummins (Columbia Univ., New York). Phys. Letters, 5: 39-40(June 1, 1963). (In English)

Observations of the output beam of a 6328 Å He–Ne maser indicate that the optical bandwidth of 9.0 kc/sec reported by Bolwijn for a laser resulted from operation of the laser in a not purely axial mode. Slight detuning of the mirrors aligned for axial mode operation broadened the beat power spectrum while changing the far-field pattern very little. Pure axial-mode operation apparently can be detected more reliably by observation of a sharp-beat spectrum than by visual inspection of a far-field pattern. (D.C.W.)

**29462** ON KANTOR'S EXPERIMENT. P. Burcev (Brno Univ.). Phys. Letters, 5: 44(June 1, 1963). (In English)

An elementary relativistic theory formulated for Kantor's experiment that supposedly refuted Einstein's postulate on light propagation gives a value for the shift that is very close to the observed value. Thus, relativity theory can explain Kantor's experiment that, therefore, does not disprove Einstein's postulate. (D.C.W.)

**29463** VORTEX RINGS AND THE CRITICAL VELOCITY IN HELIUM II. A. L. Fetter (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters, 10: 507-9(June 15, 1963).

Classical calculations on the effect of quantized vortex rings that were added to help lower the critical velocity calculated for He II predicted a critical velocity of zero. A two-dimensional model of the vortex ring is used to calculate the critical velocity as 0.08 cm/sec in contrast to an experimental value of 1 cm/sec. The model does, however, show the right dependence on tube radius. The difference between the classical and quantum treatments is also demonstrated. (D.C.W.)

**29464** GIANT MAGNETOSTRICTION IN DYSPROSIUM AND HOLMIUM SINGLE CRYSTALS. S. Legvold, J. Alstad, and J. Rhyne (Ames Lab., Ames, Iowa). Phys. Rev. Letters, 10: 509-11(June 15, 1963). (IS-649)

Magnetostriction along the axes in Dy and Ho was measured in magnetic fields up to 26 kgauss and parallel to the plane of the metal disks. Maximum linear strains ($\Delta l/l$) of $7500 \times 10^{-6}$ and $3500 \times 10^{-6}$ were observed for Dy and Ho, respectively. Strain dependence on magnetic field strength for both metals has a striking resemblance in shape to the magnetization data for the metals. The dependence of the strain on the direction of the applied field shows marked departures from the pure $\sin^2\theta$ dependence. (D.C.W.)

**29465** NEW AUTOIONIZING ATOMIC ENERGY LEVELS IN He, Ne, AND Ar. R. P. Madden and K. Codling (National Bureau of Standards, Washington, D. C.). Phys. Rev. Letters, 10: 516-18(June 15, 1963).

Absorption spectra obtained using a 180-Mev electron synchrotron as a continuum light source showed discrete structure corresponding to transitions to autoionizing states. The prominent series of autoionized lines in Ne converges to 256 Å and probably corresponds to the transitions $2s^22p^6\ {}^1S_0 - 2s2p^6np^1P_1^0$. For Ar, the transitions seem to be $3s^23p^6\ {}^1S_0 - 3s3p^6np^1P_1^0$. The first member of the prominent series in He seems to be associated with the lowest allowed transition to a two-electron excitation level ($1s^2\ {}^1S_0 - 2s2p^1P_1^0$). (D.C.W.)

**29466** CLASSIFICATION OF TWO-ELECTRON EXCITATION LEVELS OF HELIUM. J. W. Cooper, U. Fano, and F. Prats (National Bureau of Standards, Washington, D. C.). Phys. Rev. Letters, 10: 518-21(June 15, 1963).

Classification of the states that produce the autoionizing lines recently observed in spectra of He is considered. Properties of the states are discussed. (D.C.W.)

**29467** AXIALLY SYMMETRIC CONFORMASTAT ELECTROVAC UNIVERSES. Ramji Tiwari and Markan-

deya Misra (Banaras Hindu Univ., Varanasi). Proc. Natl. Inst. Sci. India, Pt. A, 28: 856-62(Nov. 26, 1962).

A class of exact solutions of the Einstein-Maxwell field equations in vacuo is obtained for an axially symmetric conformastat metric. It is found that the solution as obtained is more general than those obtained by others. It is further found that in all cases considered the electromagnetic field turns out to be real. (auth)

**29468** QUANTIZATION AND METASTABILITY OF SUPERCURRENTS. Gregor Wentzel (Univ. of Chicago). Proc. Natl. Acad. Sci. U. S., 49: 679-84(May 1963).

The idea that the metastability of currents in ring-shaped superconductors may have the same origin as the phenomenon of magnetic flux quantization was examined, with emphasis on the effects of thermal excitation. A relation with Bardeen's two-fluid model was considered. Model calculations are presented. (C.H.)

**29469** THE CAPTURE OF HOT ELECTRONS BY GOLD CENTRES IN n-TYPE GERMANIUM. R. G. Pratt and B. K. Ridley (Mullard Research Labs., Redhill, Surrey, Eng.). Proc. Phys. Soc. (London), 81: 996-1012(June 1, 1963).

Measurements of current density against electric field for specimens of n-type germanium containing gold, at 77°K indicate an increase of the capture rate with field for electrons at singly negatively charged gold centers. The effect of this is a rapid break-away from the ohmic line as soon as the electron temperature rises. Pulse-field measurements show the effect directly. Assuming the capture cross section to be of the form $AS(E) \cdot E^p T^q$ where A is a constant, S(E) the Coulomb barrier tunnelling factor, E, electron energy, T, lattice temperature, and taking the electron distribution function to be Maxwellian at high fields, the value $p = -1$ is obtained. Comparison with work on thermal equilibrium capture cross sections leads to $\frac{1}{2} \leq q \leq 1$. Although at 77°K the Coulomb barrier effect is dominant, the inverse-power dependence on electron energy of the energy-loss part of the capture cross section precludes the appearance of any distributed differential negative resistance. A good fit to experiment is obtained by taking the tunnelling Coulomb effective mass of the electron to be $0.084\ m_0$. This indicates that preferential capture of electrons travelling in {111} transverse mass planes occurs. Differences in capture effects shown by specimens with the field in a (100) direction and those with the field in a (211) direction can be explained in terms of the usual hot electron anisotropy. The absolute magnitude of the capture rate at 77°K is $6 \times 10^{-10}$ cm$^3$ sec$^{-1}$, corresponding to a capture cross section of $4 \times 10^{-17}$ cm$^2$. At fields from 2–3 kv cm$^{-1}$ a rapid rise in current density is observed. This is attributed to impact ionization of the gold center having an energy level 0.2 ev below the conduction-band edge. (auth)

**29470** SOFT X-RAY $M_{23}$ EMISSION SPECTRA FROM Fe–Co ALLOYS. J. A. Catterall and J. Trotter (National Physical Lab., Teddington, Middx, Eng.). Proc. Phys. Soc. (London), 81: 1043-6(June 1, 1963).

The $M_{23}$ emission spectra from a series of iron-cobalt alloys were examined. It is suggested that the results indicate the formation of localized 3d energy levels in this system. (auth)

**29471** EVOLUTION EQUATION FOR HOMOGENEOUS QUANTUM FLUIDS. L. Blum (Facultad de Ciencias Exactas y Naturales, Buenos Aires). Proc. Phys. Soc. (London), 81: 1056-73(June 1, 1963).

By means of a summation procedure it is shown that, by assuming random a priori phases, the evolution equation for the density matrix operator consists only of connected diagrams. A procedure to reduce sets of diagrams to more compact expressions is outlined, in particular the expression for the sum of all the diagrams with four lines is obtained. (auth)

**29472** THERMALIZATION OF POSITRONS IN AR[illegible]. S. J. Tao, J. H. Green, and G. J. Celitans (Univ. of N[illegible] South Wales, Sydney). Proc. Phys. Soc. (London), 81: 1091-1100(June 1, 1963).

The thermalization time required for positrons in argon is estimated by separating the energy range of positrons into the three regions $E > 0.01$ Mev, $0.01\ \text{Mev} > E > E_{exc}$ and $E < E_{exc}$ ($E_{exc}$ is the first excited level of the argon atom). The elastic collision cross sections determined by Marder et al. are re-evaluated. The thermalization time in the third region is not negligible compared with the free annihilation lifetime and most of the free positrons will be annihilated before being thermalized. (auth)

**29473** SECONDARY ELECTRON EMISSION FROM A CLEAN TUNGSTEN SURFACE BOMBARDED BY VARIOUS POSITIVE IONS. L. N. Large (Services Electronics Research Lab., Baldock, Herts, Eng.). Proc. Phys. Soc. (London), 81: 1101-3(June 1, 1963).

The secondary electron coefficient $\gamma$ was measured for singly charged hydrogen, helium, nitrogen, neon, oxygen, argon, and krypton ions in the energy range 10–140 kev incident on a tungsten surface. Measurements were made within the monolayer adsorption time after production of an atomically clean surface. In this energy range $\gamma$ increases with incident ion energy for all ions with the exception of protons for which a maximum is reached at around 110 kev. At constant energy the yield is progressively higher as the ion mass is increased up to that for oxygen. For neon, argon, and krypton the yield at a constant energy is, however, less than that for oxygen. At a constant ion velocity, $\gamma$ for atomic ions increases as the mass of the incident ion increases. Also, the rate of change of $\gamma$ with ion velocity for these ions increases with increasing ion mass. The yield for $H_2^+$, $N_2^+$, and $O_2^+$ ions is approximately twice that for the corresponding atomic ions at the same velocity. (auth)

**29474** GENERAL THEORY OF PERTURBATIONS IN CLASSICAL MECHANICS. L. M. Garrido (Universidad, Barcelona) and F. Gascón. Proc. Phys. Soc. (London), 81: 1115-21(June 1, 1963).

An operational method is presented for studying the effect of perturbations in classical mechanics. This method is similar to that used in quantum mechanics. Hamilton's formalism is then used. The most general case when the unperturbed hamiltonian and the perturbed hamiltonian depend explicitly on time is explained. This theory is illustrated with an example. (auth)

**29475** MAGNETIC SURFACES IN A TOROIDAL HELICAL FIELD. L. M. Kovrizhnykh. Z. Tekhn. Fiz., 33: 377-81(Apr. 1963). (In Russian)

In previous studies the magnetic surfaces were investigated for a straight helical field. Under realistic conditions traps with helical fields behave more like toroidal systems. In this investigation approximate equations were obtained for magnetic surfaces present in a toroidal helical field. A strong distortion in the magnetic surfaces was found in the central region when toroidal fields were considered. The derived equations were examined for the common case when the field was made up of band-shaped pairs of symmetrically distributed conductors wrapped in

spirals so that the currents flowing in each set of two neighboring bars were equal in value and opposite in sign. The picture for a general form of spirals does not differ very much from the one applicable for this special case. The actual view of the magnetic surfaces and the size of the disturbed regions can vary. (TTT)

**29476** ELEKTRONNO-DYROCHNYE PEREKHODY V POLUPROVODNIKAKH (Electron-Hole Transitions in Semiconductors). Tashkend, Publishing House of Academy of Sciences, 1962. 320p.

Conference papers on the production and practical applications of semiconductor devices are presented. Fifty-five papers on the correlation between activation energy, differential ionization potentials, and atomic radii, conductivity, current-voltage characteristics, and heating effects in transistors are included. Characteristics of semiconductor diodes and triodes are also considered. (C.E.S.)

**29477** APPLICATIONS OF THE ONE-FLUID AND THE TWO-FLUID MODEL IN MAGNETOHYDRODYNAMICS. Leendert Van Wijngaarden. Thesis, Delft, Netherlands, Technische Hogeschool, 1962. 107p.

Magnetohydrodynamic (MHD) equations for a fully ionized gas consisting of protons and electrons, derived from the Boltzmann equation with the help of a modified Coulomb potential, are used. MHD problems in the one and two-fluid model are treated, and the effects in the two-fluid model that are absent in the one-fluid model are investigated. The two models are applied to the forced flow of an inviscid, conducting fluid between parallel plates with a magnetic field normal to the direction of the flow. The problem is also considered when the flow is engendered by the uniform motion of one of the plates in its own plane. The flow along a thin plate with a wavy profile on both sides is also considered. The one-fluid model is applied to the flow of a conducting fluid along a thin plate, wave-shaped on both sides, in the presence of a magnetic field parallel to the plate. The unsteady phenomena occurring when the plate, moving at times $t < o$ with the fluid in the direction of the magnetic field, is suddenly brought to rest at time $t = o$. The two-fluid model is also applied to this problem. (C.E.S.)

**29478** IMPROVEMENTS RELATING TO LUMINESCENT MATERIALS OR PHOSPHORS. Robert Stirling Wells (to Associated Electrical Industries Ltd.). British Patent 927,111. May 29, 1963. Filed Mar. 25, 1960.

A luminescent material consisting of strontium aluminate activated with lead is patented. When the material is excited by short ultra-violet radiation, especially radiation with a wavelength of 2537 Å, it emits radiation in the ultra-violet region near 3000 Å. The phosphor is prepared by heating a mixture of strontium oxide and alumina with lead oxide to a temperature between 1150° and 1200°C in an oxidizing atmosphere. The strontium aluminate is cooled and reduced to a powder. The proportion in which SrO is combined with $Al_2O_3$ affects the emission of the phosphor. The material is suitable as the luminescent coating on erythemal fluorescent low-pressure mercury-vapor lamps. (M.P.G.)

**29479** HALL CURRENT GENERATOR. Richard J. Rosa (to Avco Corp.). U. S. Patent 3,091,709. May 28, 1963. Filed Mar. 28, 1960.

A magnetohydrodynamic (MHD) generator employing Hall currents to produce power is patented. The generator consists of a duct and a magnetic field normal to the axis of the duct. Movement of plasma through the duct and the field induces an emf between opposed electrodes. The electrodes are interconnected to accommodate circulation of current transversely to both the magnetic field and the direction of plasma flow. The first and last electrodes along the length of the duct are connected to an external load, permitting circulation of Hall current longitudinally through the plasma and the load circuit. The generator design achieves reduced heat loss, reduced viscous-drag losses, and a strong magnetic field over an appreciable volume of the generator. (M.P.G.)

## Astrophysics, Cosmology, and Geophysics

**29480** (NASA-TN-D-1844) COSMIC-RAY-INDUCED STABLE AND RADIOACTIVE NUCLIDES IN METEORITES. Michael E. Lipschutz (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). June 1963. 9p.

A discussion of meteoritic types is followed by presentation of the results of radiochemical and mass-spectrometric investigations on iron meteorites. From the amounts of cosmogenic stable and radioactive species present, conclusions can be drawn concerning the duration of cosmic ray exposure, the spectrum and intensity of the incident cosmic ray flux, the preatmospheric size and shape of the meteorites, and the terrestrial history of these objects. A discussion of some, as yet unanswered, questions concerning meteorites is presented. (auth)

**29481** (RM-63TMP-3) TABULAR DISPLAYS OF GEOMAGNETIC GEOMETRY. Walter F. Dudziak, David C. Kleinecke, and Theodore J. Kostigen (General Electric Co. Technical Military Planning Operation, Santa Barbara, Calif.). Apr. 1, 1963. Contract DA-49-146-XZ-109. 184p. (DASA-1377)

Computational data pertaining to the geometric properties of the geomagnetic field and a brief related theoretical description to make this material more meaningful are presented. The tables include: values of total field intensity (B) McIlwain's magnetic shell parameter (L) for altitudes from zero to two thousand kilometers, the detailed value of total field intensity near the South Atlantic anomaly, and traces in both hemispheres of points with a fixed value of B and L. Tables of the geomagnetic coefficients used and a description of the codes utilized are included. (auth)

**29482** GEOMAGNETIC DYNAMO: A LABORATORY MODEL. F. J. Lowes and I. Wilkinson (King's Coll., Newcastle upon Tyne, Eng.). Nature, 198: 1158-60 (June 22, 1963).

A mechanical model of a homogeneous self-maintaining dynamo was devised which confirmed Herzenberg's model of the earth's magnetic field. Two cylinders side by side with their axes at right angles to each other are rotated in axial magnetic fields, and it is expected that when the velocities are large enough, the induced field will be larger than the applied field, forming a self-exciting dynamo. When the cylinders were covered with insulating layers to inhibit the reverse current systems near the tops of the cylinders, a sudden increase in the induced field was observed when the speed of one cylinder was increased while the other cylinder was rotating at constant speed. (D.L.C.)

**29483** RELATION BETWEEN ATMOSPHERIC OZONE AND GEOMAGNETIC DISTURBANCES. R. N. Kulkarni (Commonwealth Scientific and Industrial Research Organi-

zation, Aspendale, Victoria, Australia). Nature, 198: 1189-91(June 22, 1963).

Results are given for a study of the behavior of the mean meridional distribution of total ozone over 15 European stations (38 to 78°N) during severe magnetic storms. The storms studied were 14 severe geomagnetic disturbances in 1957, 1958, and 1959, and the ozone distributions were studied for a period of about a week on either side of a magnetic storm. The results indicate that 24 hr after the storm, the latitudinal gradient of ozone decreases to a minimum, the amount of ozone tending to become the same at all latitudes. This involves a decrease of ozone in the 50 to 65°N region and an increase south of 50°N. Two or three days after the storm, the ozone amount increases in the 50 to 65° N region, and the latitudinal distribution approaches the distribution before the storm. Possible causes of the changes are discussed briefly. (D.L.C.)

## Cosmic Radiation

**29484** (INSJ-55) EVOLUTION OF GALAXIES AND ITS RELATION TO ORIGIN OF COSMIC RAYS. M. Taketani, Y. Fujimoto, and K. Yokoi (Tokyo Univ. Inst. for Nuclear Study). May 15, 1963. 4p.

The production and confinement of cosmic rays in our galaxy is discussed along with the origin, behavior, and properties of extra-galactic cosmic radiation. Cosmic rays are noted to play an important part in transferring energy gas clouds and magnetic fields in evolutionary processes. Radio emission by galaxies, dependent on their evolutionary state, is also related to their cosmic radiation emission. (D.C.W.)

**29485** (NRL-5951) ORIGIN OF COSMIC RAYS IN SUPERNOVAE AND OTHER SOURCES. M. M. Shapiro (Naval Research Lab., Washington, D. C. and Weizmann Inst. of Science, Rehovoth, Israel). Mar. 28, 1963. 6p.

The most powerful galactic sources of cosmic radiation appear to be supernova explosions. Among the characteristics that suggest that their expanding gaseous envelopes provide suitable conditions for cosmic-ray origin are the following: an enormous energy release, a copious supply of relativistic electrons, large-scale magnetic fields, extended masses of plasma moving at high velocities, indications of the propagation of hydromagnetic waves, and relatively high concentrations of heavier elements. Several mechanisms of acceleration are sketched. Some difficulties with the supernova hypothesis, and with other possible modes of origin, are briefly discussed. (auth)

**29486** ENERGY SPECTRUM OF PRIMARY COSMIC RAYS IN THE RANGE $10^{10}$-$10^{15}$ ev. G. Brooke, P. J. Hayman, Y. Kamiya, and A. W. Wolfendale (Univ. of Durham, Eng.). Nature, 198: 1293-4(June 29, 1963).

An examination of the energy spectra of cosmic-ray muons and protons at sea level was made in order to estimate the primary cosmic-ray energy spectrum. Cocconi's model of interaction of high-energy nucleons was used, and $K-K_\pi \cong 0.15$ was assumed, where K = fraction of energy lost by a high-energy nucleon in collision with an air nucleus, and $K_\pi$ = fraction appearing as pions. The derived primary spectrum is compared with other estimates. (D.L.C.)

**29487** ON THE ENERGY LOSS OF MUONS AND THEIR MOMENTUM SPECTRUM. M. J. Campbell, H. S. Murdoch, K. W. Ogilvie, and H. D. Rathgeber (Univ. of Sydney). Nuovo Cimento (10), 28: 885-901(June 1, 1963). (In English)

Results on the momentum spectrum under 7.2 kg $cm^{-2}$ of rock were extended to lower momenta in order to test the expected rate of momentum loss in the rock. The low-momentum spectrum is quite sensitive to this. Taking the results together with previous ones, the spectrum agrees over the whole range of momentum from 250 Mev/c to 200 Bev/c with the sea-level spectrum when due allowance is made for momentum loss. The correct form of collision loss gives much better agreement than a constant momentum-loss approximation but inclusion of other forms of energy loss is immaterial for the spectrum. The intensity at greater depths corresponding to energies up to 500 Bev is shown to be higher than can be expected on any reasonable assumptions about energy loss. Attention is drawn to the large uncertainty in nuclear energy loss at energies > 1000 Bev and the difficulty, as a result of this, in deducing the spectrum from intensity measurements deep underground. (auth)

**29488** SOME STATISTICAL AND KINEMATICAL COMMENTS ON HIGH-ENERGY JETS. K. Kobayakawa (Osaka Univ.), K. Mori, K. Daiyasu, and H. Yokomi. Nuovo Cimento (10), 28: 992-1010(June 1, 1963). (In English)

Statistical and kinematical problems necessary for the analysis of high-energy jets using fire-ball models are studied. The laboratory integral angular distributions of secondaries emitted from the fire ball are calculated. In the rest system of the fire ball, types of energy and angular distributions are assumed and effects of relatively small velocities of secondaries compared to the velocity of the center of energy of the fire ball in the laboratory system are investigated. The statistical tests are made in order to see, between the two-fire-ball model and Hasegawa's model, which one is more favorable to explain the experimental data. The massive object observed by Hasegawa (H-quantum) is examined to determine whether it decays isotropically or in the angular distribution of $\sin^2\theta^*$ type in its rest system. The position and width of characteristic peaks in the frequency distribution of the Lorentz factor of H-quanta by the method of k-statistics (momentum method) are checked. It is concluded that the two-fire-ball model in its original form can be rejected statistically. Hasegawa's model seems to be more favorable than the two-fire-ball model if the accumulated data is considered. (auth)

**29489** THE RATE OF ENERGY LOSS OF COSMIC RAY MUONS IN A NEON–METHANE MIXTURE. D. G. Jones, R. H. West, and A. W. Wolfendale (Univ. of Durham, Eng.). Proc. Phys. Soc. (London), 81: 1137-9(June 1, 1963).

A measurement was made of the most probable energy loss of muons in a neon-methane mixture as a function of momentum over the range 0.3–30 Bev/c. When the results are normalized to the Landau theory at one momentum there is good agreement with expectation over the whole range. (auth)

## Elementary Particles and Radiations

**29490** (AEET/CD/12) PERTURBATION THEORY OF MANY PARTICLE SYSTEMS. [PART] I. P. G. Khubchandani and C. Manohar (India. Atomic Energy Establishment, Trombay). 1963. 18p.

Studies are being made to examine the effects of phonon-phonon interactions on neutron scattering in crystals. This involves the use of the resolvent operator and the diagram techniques. In order to become familiar with the resolvent operator, a general perturbation theory was developed from which the familiar forms of it could be derived as special cases. The Brillouin–Wigner and Raleigh–Schrodinger perturbation theories were derived. (M.C.G.)

**29491** (BNL-6340) PION RESONANCES IN $\pi^- - p$ INTERACTIONS AT 4.65 Bev/c. E. A. Munir (Ohio Univ., Athens) and G. T. Zorn (Brookhaven National Lab., Upton, N. Y.). Aug. 9, 1962. Contract [AT(30-2)-Gen-16]. 9p.

The Q-values and effective mass distributions for the pion combinations resulting from the interactions $\pi^- + p \rightarrow \pi^- + \pi^0 + p$ and $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ at 4.65 Bev/c were obtained. The $\rho$ resonance occurred in both plots; and, for the second reaction, an accumulation of events at a mass of about 1250 Mev was also observed. The $\rho$ resonance was also observed in the kinetic energy distributions for the nucleons from these interactions, and additional evidence for some phenomena at 1250 Mev appeared in distributions for the second interaction. (D.C.W.)

**29492** (BNL-7033) Mu-p SCATTERING EXPERIMENT—TRIGGER AND DRIVE CIRCUITS. Mu-p No. 26. Michael J. Tannenbaum (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). May 1963. Contract [AT(30-2)-Gen-16]. 67p.

Block diagrams of the apparatus to be used in the experiment are presented; and the design, behavior, and operation of the various circuits are discussed. (D.C.W.)

**29493** (CERN-63-14) SELECTED TOPICS ON SCATTERING THEORY. PARTS II AND III. II. RECAPITULATION OF QUANTUM MECHANICS. III. FORMAL THEORY OF SCATTERING. (European Organization for Nuclear Research, Geneva). Apr. 11, 1963. 182p.

The principles of quantum mechanics are reviewed, and the formal theory of scattering is presented in the time-dependent and time-independent formulations. (D.C.W.)

**29494** (CERN-63-15) PROBLEMS AND TRENDS IN THE THEORY OF ELEMENTARY PARTICLES. (European Organization for Nuclear Research, Geneva). Apr. 16, 1963. 42p.

Analyticity and unitarity of the s-matrix, Regge poles, field theory, quantum electrodynamics, and the various connections among these are among the subjects discussed. (D.C.W.)

**29495** (CERN-63-20) KINEMATICAL TABLES FOR TWO-BODY DECAYS FROM 0.05 TO 25.0 Gev/c. Roberto A. Salmeron (European Organization for Nuclear Research, Geneva). May 31, 1963. 736p.

Information on the angles, energies, momentums, and velocities involved in the two-body decays of $\pi$ and K mesons and of $\Lambda$, $\Sigma$, and $\Xi$ hyperons is included. The momentum range from 0.05 to 25.0 Bev/c is covered. (D.C.W.)

**29496** (IA-834) THE CROSSING MATRIX IN THE GELL-MANN–NE'EMAN MODEL. H. Goldberg (Israel. Atomic Energy Commission, Rehovoth). Mar. 1963. 12p.

The crossing matrix that determines the t-channel wave when the form of the s-channel wave is given is discussed. The case when the four particles involved in an annihilation process all belong to octets is considered. The reduction of the basis of (11) × (11) and the scalars in the basis of (11) × (11) × (11) × (11) are given. The representations (22), (30), and (03) of SU(3) were calculated and are presented along with the representation (11). (auth)

**29497** (NEVIS-114) PRECISION LIFETIME MEASUREMENT ON POSITIVE AND NEGATIVE MUONS. S. L. Meyer, E. W. Anderson, E. J. Bleser, L. M. Lederman, J. L. Rosen, J. E. Rothberg, and I. T. Wang (Columbia. Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). May 1963. Contract Nonr-266(72) 26p. (R-366; Cu-220)

An experiment to measure and compare the free decay rates of positive and negative muons is described. Muons from the Nevis Synchrocyclotron were stopped in a liquid hydrogen target containing less than 1 ppm $D_2$ and less than 1 part in $10^9$ of other impurities. In this situation, the rate of $\mu^-$ capture in $H_2$ was the only significant correction to the free decay rate of $\mu^-$ and was measured in a separate experiment. The lifetimes were monitored by measuring the time intervals between muon stops and decay electrons using a transistorized digitron of 30 nsec channel width. Electronic circuitry of the "interference remover" type was employed to eliminate time-dependent background. $\mu^-$ and $\mu^+$ lifetimes were measured with the same apparatus and under essentially the same conditions of rate and geometry. The ratio of the lifetimes is expected to be particularly insensitive to any systematic errors. The results are: $\tau_{\mu^-} = 2.198 \pm 0.002$ $\mu$sec (hydrogen correction made); $\tau_{\mu^+} = 2.197 \pm 0.002$ $\mu$sec; and $R = \tau_{\mu^-}/\tau_{\mu^+} = 1.000 \pm 0.001$. (auth)

**29498** (NP-12945) A NANOSECOND TIME-TO-PULSE HEIGHT CONVERTER AND ANALYSER FOR POSITRON LIFETIMES. J. Bell, G. J. Celitans, S. J. Tao, J. W. Lee, and J. H. Green (New South Wales, Australia. Univ., Kensington). [nd]. 20p.

A prompt gamma photon (1.28 Mev) and a delayed annihilation photon (0.51 Mev) are observed at the beginning and end of the nanosecond lifetime of a positron. A time-to-pulse height converter was built to determine the short time interval between the pulses from two scintillation counters, that observe the photons. The lengths and times of travel of the pulses are carefully matched. The time interval, or the overlap time of the two pulses, determines the pulse width of a constant amplitude output pulse from a 6BN6 gated beam tube. This output pulse in turn determines the pulse height output from a ramp generator and a time-to-amplitude conversion is thus achieved. Undesirable coincidences are eliminated by providing side channels, which include discriminators and a coincidence unit. The output from the converter is connected to a 512-channel pulse height analyser. The performance of this system in determining the decay life-time of positrons in various substances is described. The half-width at half height for the $Co^{60}$ prompt gamma is less than 1.5 ns. (auth)

**29499** (NP-12946) MEASUREMENT OF TRIPLE-COINCIDENCE PULSES FROM SCINTILLATION DETECTORS FOR THE STUDY OF POSITRON ANNIHILATION. J. Bell, G. Celitans, and J. H. Green (New South Wales, Australia. Univ., Kensington). [nd]. 25p.

The properties of positronium (the electron-positron bound state) may be studied by detecting in triple-coincidence the three photons that appear when annihilation eventually occurs. This is accomplished by using three photomultiplier-plastic scintillator gamma detectors in a fast coincidence circuit with arrangements for side channel pulse analysis. The photomultipliers in use give a low output voltage, and pulse shaping triggers are therefore used before the pulses are admitted to a coincidence unit of 10 nsec resolving time. A small resolving time is required to minimize random coincidences. Three single-channel analysers are used in the side channels for pulse sorting of the required annihilation photons. These ana-

lysers are based on Moody triggers to give fairly fast rise-time amplifications and analysis (dead-time-approx. 10 microsecond). The outputs of the three analysers and the triple-coincidence unit are finally fed to a quadruple-coincidence unit to give the final coincidence count. The design and performance of the system are described, and selected results are given to show its versatility. (auth)

**29500** (NYO-10268) CONSEQUENCES OF $SU_3$ INVARIANCE. E. C. G. Sudarshan (Rochester, N. Y. Univ.). Apr. 27, 1963. Contract AT(30-1)-875. 50p.

Charge independence is shown to dictate 14 relations in 5 different quantities between the 19 cross sections for $\pi + \Sigma$ interactions. Charge independence together with invariance under the Weyl reflections is noted to constitute invariance under the $SU_3$ group. A list of octet reactions and decays is given along with the derived relations from $SU_3$ invariance that are linear in the cross sections. Variance breaking effects are estimated, and the consequences of approximate $SU_3$ invariance are considered. Relations for the decay of decuplet and octet baryon resonances are derived and compared with experimental information. The electromagnetic properties of unitary multiplets are also examined. (D.C.W.)

**29501** (UCRL-8030(Rev. Apr.'63, Ed.)) DATA FOR ELEMENTARY-PARTICLE PHYSICS. Walter H. Barkas and Arthur H. Rosenfeld (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1963. Contract W-7405-eng-48. 31p.

Information on particle decays, scattering, properties, reaction dynamics, interactions, resonances, and atomic and nuclear constants is included. The atomic and nuclear properties of some materials often used as particle absorbers and detectors are also presented. (D.C.W.)

**29502** (UCRL-10492) STRONGLY INTERACTING PARTICLES AND RESONANCES. Arthur H. Rosenfeld (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1962. Contract W-7405-eng-48. 62p.

Information on resonances and strongly interacting particles is presented. Areas discussed include basic interactions, conservation laws, selection rules, quantum numbers, multiplets, Regge trajectories, $\rho$-production in peripheral collisions, and mesons ($\eta$,$\omega$,K) decay into $3\pi$. Particle properties, particles and resonances, Dalitz plots, Chew-Frautschi plots of baryons and mesons, and other information is displayed. 30 references. (D.C.W.)

**29503** (UCRL-10762) THE EFFECTS OF FINAL-STATE INTERACTIONS ON SCATTERING PROCESSES. (thesis). John R. Gillespie (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 9, 1963. Contract W-7405-eng-48. 73p.

Particles in the incident or final channel of a scattering process may interact to modify the experimental spectra. These interactions provide information of particles not susceptible to direct scattering experiments. Accounting for such interactions often reveals details of production processes otherwise masked by the final-state effects. The various theoretical techniques developed to accommodate these interactions are analyzed, compared, and extended to give a unified approach to the subject. There are two general approaches to the problem: factorization from the transition matrix of the wave function describing the interacting pairs, and application of time-reversal invariance and unitarity to the multichannel S-matrix to relate the phases of various elements. In the study of the former approach, extensive use is made of Jost function techniques, which provide considerable insight into the relation of the various enhancement factors arising from final-state interactions. They are especially useful in an assessment of various approximation methods and in an understanding of the distinction between the effects of attractive and repulsive interactions. The symmetry of initial and final-state effects is examined. The methods for a single interacting pair are extended to accommodate multiple simultaneous final-state interactions by means of separable and additive potentials. Analyticity and unitarity applied to Born calculations are shown to yield singular integral equations whose solutions provide a convenient correction for final-state effects; application is made to the photodetachment of negative ions. The possibility of detecting pair interactions in final states whose kinematics are incompletely determined because of unobserved particles is discussed. 66 references. (auth)

**29504** (UCRL-10834) HIGH ENERGY KAON-NUCLEON SCATTERING (thesis). Ismail A. Sakmar (California. Univ., Berkeley. Lawrence Radiation Lab.). May 1963. Contract W-7405-eng-48. 84p.

Backward and forward elastic $K - N \rightarrow K - N$ and $\overline{K} - N \rightarrow \overline{K} - N$ scatterings at high energies are studied. The amplitudes of these processes as well as of the process $K-\overline{K} \rightarrow N-\overline{N}$ are expressed in terms of suitable partial wave amplitudes in crossed channels. These latter are analytically continued into the complex angular momentum plane, and the scattering amplitudes are approximated in terms of Regge poles. The quantum numbers of all three channels are discussed, and a correspondence is made between poles and known particles. In this respect there is a clear distinction between K–N and $\overline{K}$–N scattering. A variety of particles has been discovered with the quantum numbers of the $\overline{K}$–N channel whereas in the K–N channel there are no known particles. As a result different behaviors are expected in backward scattering. Since the particles controlling the backward scattering are fermions, fermion trajectories are discussed from the point of view of recent developments. The contributions of the Regge poles in the $K-\overline{K} \rightarrow N-\overline{N}$ process to forward $K-N \rightarrow KN$ and $\overline{K}-N \rightarrow \overline{K}-N$ scatterings are calculated. Differential cross section formulas for forward and backward scattering as well as total cross sections are given in terms of trajectories and residues. 27 references. (auth)

**29505** (UCRL-10894) ROLE OF STRANGE-PARTICLE FINAL STATES IN SPIN ANALYSIS OF NUCLEON ISOBARS. Gideon Alexander, Orin Dahl, Laurence Jacobs, Donald H. Miller, George Kalbfleisch, Joseph Schwartz, and Gerald A. Smith (California. Univ., Berkeley. Lawrence Radiation Lab.). July 1, 1963. Contract W-7405-eng-48. 9p.

A preliminary partial wave analysis of data on the reaction $\pi^- + p \rightarrow \Sigma^- + K^+$ at 1500 to 2360 Mev/c indicates that a $J = 9/2$ spin state of the 2190-Mev $\pi$-N resonance recently discovered at Brookhaven's alternating-gradient synchrotron is favored over $J = 7/2$ or $5/2$. The angular distributions and cross sections analyzed are included along with those for $\pi^- + p \rightarrow \Lambda^0 + K^0$ reactions that are also being investigated. (auth)

**29506** THE PRESENT STATUS OF THE NEW RESONANCES. A. P. Balachandran and H. Pietschmann (Universität, Vienna). Acta Phys. Austriaca, 16: 159-76(1963). (In English)

The available experimental material on the resonances observed in systems of strongly interacting particles was presented. An attempt is made to confine the material to well-established facts and although references to the

various phenomenological models proposed to understand these resonances are given, none of the conclusions reached purely from such models are included in the tables for these resonances. (auth)

**29507** THE TWO MESON APPROXIMATION FOR A STATIC MODEL OF THE Λ AND Σ HYPERONS. Otto Reinhold Fetzmann (Universität, Vienna). Acta Phys. Austriaca, 16: 188-202(1963). (In English)

The physical state of the Λ and Σ hyperons in the two-pion approximation in a model with restricted baryon symmetry was calculated on the basis of the static model for an expanded source. The method of moments proposed by Halpern is used for the calculation. A very low binding energy of the $\Lambda-\pi$ or $\Sigma-\pi$ system and a very small probability for the presence of the meson cloud around the static source were obtained. (tr-auth)

**29508** THE FEYNMAN–GELL-MANN EQUATION IN THE SPINOR SPACE. GEOMETRICAL INTERPRETATION OF THE HELICITY OF THE ELEMENTARY PARTICLES. J. Morzymas (Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 181-6(1963). (In English)

The Feynman–Gell-Mann equations in the four dimensional spinor space are obtained. It is shown that this spinor space provides a basis for geometrical interpretation of the helicity of the elementary particles. (auth)

**29509** THE RADIATIVE ENERGY AND THE MOTION OF PARTICLES. M. Demiański and E. Infeld (Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 223-6(1963). (In English)

The energy of a group of N bodies is derived from the integral form of the Einstein field equations. The energy radiation is obtained by differentiating this energy expression by the time coordinate. The ninth and tenth order energy radiation are compared to obtain an equation characterizing the motion. A simple example of two bodies in circular motion is demonstrated. (C.E.S.)

**29510** CALCULATION OF THE MULTIPLE SCATTERING OF ELECTRON TRACKS IN NUCLEAR EMULSIONS USING THE CENTER OF GRAVITY METHOD AND THE SUM METHOD. Jeannine Fitan, Denise Schune-Boisblé, and Tsai-Chü (Laboratoire de Physique-Enseignement, Sorbonne, Paris). Compt. Rend., 256: 4409-11(May 20, 1963). (In French)

For the same series of measurement data, the statistical error for the pv value, calculated by the center of gravity method and the sum method, is about half the statistical error of the usual method. (tr-auth)

**29511** PHOTOPRODUCTION AND ELECTROPRODUCTION OF VERY HIGH ENERGY MUONS. Gérard Clément (Collège de France, Paris). Compt. Rend., 256: 4604-7 (May 27, 1963). (In French)

The cross sections for the production of muon pairs were calculated for photons and electrons under conditions appropriate for production of a well-collimated beam of extremely relativistic muons. (tr-auth)

**29512** DIRECT PRODUCTION OF ELECTRON PAIRS BY 16-Bev $\pi^-$ MESONS IN NUCLEAR EMULSIONS. Silvio Mora (Università, Parma, Italy). Compt. Rend., 256: 4650-2(May 27, 1963). (In French)

The electromagnetic interaction of charged particles heavier than electrons with production of electron pairs in the Coulomb field of the nucleus was studied using nuclear emulsions irradiated with $\pi^-$ mesons at 16 Bev. On a total course of 244.5 m, 23 events with pair energy above 10 Mev were found and classified as true examples of the direct production of electron pairs by $\pi^-$ mesons. The mean angle of deviation of the incident particle was less than 0.5. Geometric loss was deduced in four events by analysis of the distribution of the angles between the horizontal plane and the planes formed by the electrons and the primary. The presence of "pseudo-triplets" can be considered negligible. The distribution of the transverse moments of the electrons is shown graphically. (J.S.R.)

**29513** WAVE FUNCTIONS, AND THE CALCULATION OF MATRIX ELEMENTS FOR A LONGITUDINALLY POLARIZED VECTOR PARTICLE. A. A. Bogush (Inst. of Physics, Bulgarian Academy of Sciences). Dokl. Akad. Nauk SSSR, 149: 1286-9(Apr. 21, 1963). (In Russian)

With the experimental detection of particles with a spin of 1, the development of a theory of vector mesons is of great interest. A compact matrix representation of the wave functions of a vector meson is presented within the frame-work of a 10-dimensional $\beta$-formalism. A calculation of various interaction effects involving a longitudinally polarized particle with a spin of 1 can be carried out on the basis of a covariant method of directly calculating the matrix elements. In order to use the technique of spur matrices, the matrix-diode $\psi_1, \overline{\psi}_2$ must be expressed as $10 \times 10$-matrices of Daffine-Kemmer. A projection matrix, separating out the tensor part of the 10-dimensional space, is used in the computations. (TTT)

**29514** CONTRIBUTION TO THE STATISTICAL GEOMETRIC BASIS OF RADIATION SCATTERING. H. L. Frisch and F. H. Stillinger (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 38: 2200-7(May 1, 1963).

A description is given of a number of formal properties of the hierarchy of correlation functions describing the statistical geometry of a random porous medium consisting of homogeneous matter and void regions. The principal result concerns the determination of the average number of interparticle contacts in a randomly packed aggregate of monodisperse hard spheres. It is indicated how this number can be determined, in principle, from the analysis of large angle scattering of radiation. A discussion is given of the bearing of the result on the Debye "random scatterers" and the study of models of random close packing of spheres. A brief list of possible applications and open problems suggested by this field is given. (auth)

**29515** STUDY OF THE SIMULATION OF INELASTIC EVENTS IN $\pi^-$-NUCLEI CASCADES. Jean Grea (Institut de Physique Nucléaire, Lyon). J. Phys., 24: 14-16(Jan. 1963). (In French)

When simulating by the Monte-Carlo method inelastic $\pi^- - N$ events it is noticed that the conservation equations leave indetermined a certain number of parameters defining the state of the particles after the impact. The value of these parameters is obtained by drawing them at random. One studies the optimum choice of the parameters drawn, the area in which they were drawn in order to obtain values compatible with the conservation equations and experimental distributions. (auth)

**29516** DETERMINATION OF THE POTENTIAL BY MEANS OF THE SCATTERING AMPLITUDE ANALYTIC PROPERTIES. Mikuláš Blažek. Mat. Fysik. Casopis, 13: 172-5(1963). (In English)

A method for determining the potential in the Schroedinger equation from the known analytic properties of the partial scattering amplitude in the upper half plane of the complex momentum in the case of nonrelativistic scattering of two zero-spin particles is presented. (C.E.S.)

**29517** THE ANTISYMMETRIC WAVE FUNCTIONS OF NUCLEON SYSTEMS. [PART] I. Kh. Mueller (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Nucl. Phys., 44: 1-21(June 1963). (In German)

The symmetry operations that appear in the theory of symmetry characters are represented by matrices, the properties of which are investigated. The results allow one to analyze the structure of the total antisymmetric wave-functions, especially the hidden symmetries, and to reduce the necessary symmetry operations to a minimum. It is shown how the difficulty of introducing orthogonal systems may be avoided. (auth)

**29518** BREMSSTRAHLUNG MECHANISM OF THE MULTIPLE PRODUCTION PROCESS IN NUCLEON-NUCLEON COLLISIONS. Z. Chyliński (Univ. of Copenhagen). Nucl. Phys., 44: 58-77(June 1963). (In English)

Multiple meson production is treated as a bremsstrahlung process. Scalar coupling between nucleon and pion fields is assumed, which leads to high inelasticity of the collision and a high multiplicity of the produced pions. The direct pion-pion interaction is neglected and the time of interaction is identified with the overlapping time of the meson cloud surrounding the physical nucleon. A nucleon core is introduced to cut down the energy of the secondaries to a reasonable value. Satisfactory agreement with the experimental data is obtained for the value of the coupling constant known from low energy physics. The numerical results concerning the angular distributions, spectra of the momenta and transverse momenta of the secondary particles and their multiplicity are presented in figures. (auth)

**29519** STABILITY CONDITIONS FOR FERMION SYSTEMS. Zygmunt Galasiewicz (Univ. of Wroclaw, Poland). Nucl. Phys., 44: 107-15(June 1963). (In English)

A new formulation of the generalized Hartree-Fock variational principle is given. The functions that are subject to variations are quadratic forms in the functions that are varied in the method of Hartree-Fock or Bogolyubov. For the problem of nuclear matter the sign of the second variation of the average energy was examined for the solutions of the Hartree-Fock and Bogolyubov type. (auth)

**29520** REGGE POLE METHOD AND ONE-MESON APPROXIMATION. D. S. Chernavsky, I. M. Dremin, E. L. Feinberg, and I. I. Royzen (Lebedev Physical Inst., Moscow). Nucl. Phys., 44: 116-22(June 1963). (In English)

All the main results of the Regge pole method concerning the asymptotic behavior of cross sections are also given by the one-particle approximation, if additional quantities are specified. The one-particle approximation, moreover, gives some basic characteristics of inelastic processes. (auth)

**29521** USE OF ANALYTICAL PROPERTIES OF PROTON-PROTON SCATTERING AMPLITUDE FOR THE DETERMINATION OF THE NUCLEON-MESON COUPLING CONSTANT. V. I. Lendyel and B. M. Ernst (Univ. of Uzhgorod, Ukrainian USSR). Nucl. Phys., 44: 173-5(June 1963). (In English)

The N-$\pi$ coupling constant $f^2$ is determined via the analytical properties of the p-p scattering amplitude. The value $f^2 = 0.071 \pm 0.011$ is obtained. (auth)

**29522** AN INVESTIGATION OF JETS BASED ON MESON-NUCLEON COLLISION. INTERPRETATION OF NUCLEON-NUCLEON COLLISION. K. Imaeda (Dublin Inst. for Advanced Studies). Nuovo Cimento (10), 28: 908-22(June 1, 1963). (In English)

An investigation on jets of energy of $(10^{11}-10^{15})$ ev was made on a basis of an interpretation that nucleon-nucleon collisions may be regarded as being composed of two independent composite meson($\pi$)-nucleon collisions. A method is developed of deriving the momentum distribution and energy of the meson($\pi$) in the proper field of the nucleon using the experimentally observed distribution of the secondary particles of jets. The experimental distribution and the momentum of interaction are compared with theoretical predictions, calculated on a basis of Planck's distribution for the momentum of the meson($\pi$) in the proper field of the nucleon. Based on the results, several possible models of the structure of the nucleon and the nature of nuclear interaction are discussed. (auth)

**29523** ABSOLUTE DIFFERENTIAL CROSS-SECTION FOR ELASTIC PROTON-PROTON SCATTERING AT 0.97 Gev. W. K. McFarlane, R. J. Homer, A. W. O'Dell, E. J. Sacharidis, and G. H. Eaton (Univ. of Birmingham, Eng.). Nuovo Cimento (10), 28: 943-51(June 1, 1963). (In English)

The absolute differential cross section for elastic p-p scattering was measured for an energy of 0.97 Bev at 5, 20, 25, 30, and 35° in the laboratory system. The data fit the unpolarized differential cross-section curve. A total elastic cross-section of $(26.8 \pm 2.3)$ mb and a forward scattering cross section of $(21.4 \pm 0.5)$ mb/sr, which is considerably in excess of the optical theorem minimum of $(16.3 \pm 0.2)$ mb/sr, were obtained. (auth)

**29524** RADIATION-GAUGE ELECTRODYNAMICS. II. THE ASYMPTOTIC CONDITION. C. R. Hagen (Massachusetts Inst. of Tech., Cambridge). Nuovo Cimento (10), 28: 970-81(June 1, 1963). (TID-17326 (Pt.11)) (In English)

The use of the asymptotic condition in electrodynamics is criticized and an alternative approach suggested that utilizes specific properties of the radiation-gauge Green's functions. This technique is based upon the introduction of a nonlocal field operator that has the property of asymptotically creating physical electrons without the usual emission of soft quanta. It is shown by means of an example how a cross-section may be calculated without either the appearance of spurious infrared divergences or the improper imposition of an asymptotic condition. (auth)

**29525** THE $\pi$-MESON AS A BOUND NUCLEON-ANTINUCLEON STATE. J. Mandelbrojt (Université d'Aix, Marseille). Nuovo Cimento (10), 28: 982-91 (June 1, 1963). (In English)

The creation operator of the meson($\pi$) considered as a bound nucleon-antinucleon state is presented. When the Fermi self-interaction of the nucleon-antinucleon field is given, the expression of the clothed nucleon and the bound state corresponding to the meson($\pi$) can be obtained. Properties of the meson($\pi$) creation operator are discussed. (C.E.S)

**29526** INTERACTION ENERGY IN A CONFIGURATION OF THREE EQUIVALENT PARTICLES. D. Sperber (Armour Research Foundation, Chicago). Nuovo Cimento (10), 28: 1024-36(June 1, 1963). (In English)

The interaction energy for a configuration of three equivalent particles can be described as a linear combination of the allowed terms in the two-particle configuration. The interaction energy for three particles is calculated in (jj) coupling without the use of coefficients of fractional parentage. It is shown how to construct a set of mutually orthogonal wave functions when there is more than one state with the same J value. (auth)

**29527** INTERACTION ENERGY IN A CONFIGURATION OF SEVERAL GROUPS OF MANY EQUIVALENT PARTICLES. D. Sperber (Armour Research Foundation, Chicago). Nuovo Cimento (10), 28: 1037-48(June 1, 1963). (In English)

The interaction energy in (jj) coupling for a configuration consisting of one and two groups of equivalent particles is calculated, without the use of the coefficients of fractional parentage, as a linear combination of terms appearing in a two-particle configuration. It is shown that the coefficients in the linear expansion are products of vector-recoupling coefficients. Configurations containing one and two groups of equivalent particles are discussed. (auth)

**29528** ON THE EXISTENCE OF THE SCATTERING OPERATOR. N. Limić (Institute "Rudjer Boskovic," Zagreb). Nuovo Cimento (10), 28: 1066-90(June 1, 1963). (In English)

The existence of the wave operators and the scattering operator for the scattering on highly singular spherically symmetric potentials that are repulsive at the origin is shown. The eigenfunction expansion in terms of the eigenfunctions of the hamiltonian is derived using the analytic properties of the solution of the Schroedinger equation. (auth)

**29529** GYRO-GRAVITATIONAL RATIO OF DIRAC PARTICLES. A. Peres (Israel Inst. of Tech., Haifa). Nuovo Cimento (10), 28: 1091-2(June 1, 1963). (In English)

It is shown that the iterated Dirac equation, in presence of a gravitational field, does not contain any spin-curvature coupling. In contrast with the equation of motion of a classical spinning particle. (auth)

**29530** SIGN OF THE $K_1^0-K_2^0$ MASS DIFFERENCE. U. Camerini, W. F. Fry, and J. Gaidos (Univ. of Wisconsin, Madison). Nuovo Cimento (10), 28: 1096-7(June 1, 1963). (In English)

A method is proposed to measure the sign of the $K_1^0-K_2^0$ mass that involves the production of a $K^0$ in a strong interaction, such as $K^+$ charge exchange or associated production, followed by a scattering and subsequent decay in the $K_1^0$ mode. (C.E.S.)

**29531** NUCLEON-PION Q VALUES. R. M. Kalbach and R. J. Piserchio (Univ. of Arizona, Tucson). Nuovo Cimento (10), 28: 1101-2(June 1, 1963). (In English)

Evidence for the existence of an isobar with isotropic spin $\frac{3}{2}$ from proton-proton collisions at 3.5 Bev was investigated. The isobar can decay into any combination of nucleon and meson($\pi$), depending on the Z-component of the isotropic spin. An attempt was made to limit the sample of events to those with a single neutron or meson($\pi^0$). All events with two secondary tracks were subjected to a missing mass calculation to determine which events had only one secondary meson($\pi$). Q values for all combinations of nucleon-meson($\pi$) pairs were calculated. Approximately 45% had Q values that indicate an isobar decay. (C.E.S.)

**29532** PION-NUCLEON INTERACTION AT ABOUT 2 Gev AND THE $f^0$-MESON. S. Minami (Louisiana State Univ., Baton Rouge). Nuovo Cimento (10), 28: 1103-6 (June 1, 1963). (In English)

A model for the meson($\pi$)-nucleon interaction at about 2 Bev is used to calculate the effect of the meson($f^0$). The meson($f^0$) is produced through the one meson($\pi$) exchange process. There is a maximum in the interaction total cross section with excitation energy slightly above the threshold energy for $\pi + N \rightarrow f^0 + N$ production, and the $I = \frac{1}{2}$ state in the ($\pi-N$) system is responsible for this maximum because the isotropic spin of the meson($f^0$) is zero. On the basis of the model, the total angular momentum and parity states responsible for the maximum of the total cross section ($\pi^- - p$) at 2 Bev are discussed. The angular distributions of the meson($f^0$) are also given. (C.E.S.)

**29533** ON THE INELASTIC DEUTERON FORM FACTOR. L. Rosenberg (Univ. of Pennsylvania, Philadelphia). Nuovo Cimento (10), 28: 1107-10(June 1, 1963). (In English)

The similarity that exists between the deuteron form factor and the off-the-mass-shell neutron-proton scattering amplitude when final state neutron-proton interactions are accounted for in the impulse approximation for the inelastic scattering of a particle by a deuteron is discussed. The Lippmann-Schwinger integral equation for the two-nucleon wave function in the final state and the reciprocity and space reflection invariance properties of Green's function are used in the derivations. (C.E.S.)

**29534** ON THE $\Lambda-\Sigma$ PARITY IN THE NON-LINEAR SPINOR THEORY. L. Castell (University Coll., London). Nuovo Cimento (10), 28: 1111-12(June 1, 1963). (In English)

The eigenvalue equation for the energy in the rest system is obtained from the generalized field equation for baryons with spin $\frac{1}{2}$ and strangeness $\pm 1$. The parity operator has the eigenvalues $\pm 1$. Two solutions for the energy equation are obtained when the experimental value of the hyperon ($\Lambda$) and ($\Sigma$) masses and parity values of $\pm 1$ are substituted into the energy equation. (C.E.S.)

**29535** HYDROGEN-DEUTERIUM DISCREPANCY AND $\bar{K}-A$ BOUND STATE. M. D. Warty (Univ. of Delhi). Nuovo Cimento (10), 28: 1113-14(June 1, 1963). (In English)

A solution for the discrepancy in the $K^--H$ and $K^--D$ absorption data is suggested by considering the $Y_1^*$ as a $\Sigma-\pi$ resonance resulting from a $\bar{K}-N$ virtual bound state. It is shown that the assumption of binding energy of $\bar{K}$ to nucleons increases the amplitude phase differences in the H and D cases. The agreement with the amplitude phase differences can be improved even more if the binding energy per nucleon in the $K^--D$ case is greater than that in $K^- - p$. (C.E.S.)

**29536** A COVARIANT POSITION OPERATOR. APPLICATION TO A SYSTEM OF TWO PARTICLES. H. Bacry (Institut de Physique Théorique, Marseille). Phys. Letters, 5: 37-8(June 1, 1963). (In English)

A covariant mass-center operator that differentiates, in a two-particle system, between orbital and spin angular momenta is obtained. Application to a two-particle system is demonstrated. (D.C.W.)

**29537** INFRARED SINGULARITIES AND THE POSITRONIUM SPECTRUM. L. D. Solov'ev (Univ. of Copenhagen). Phys. Letters, 5: 51-3(June 1, 1963). (In English)

Compton scattering from an arbitrary charged elementary particle is treated by the Bogoliubov dispersion relation method in order to examine the term $\Phi(t)[(m^2 - s)/m^2]^{\beta(t)-1}$ that occurs in the dispersion relations in quantum electrodynamics instead of the usual pole term $(s - m^2)^{-1}$ of meson theory. Here, t is the momentum transfer, and s is the energy. A singularity in the amplitude due to the exchange of infrared photons has poles defined by the Regge equation giving the positronium spectrum. The Regge equation and a function of the $\beta$ occurring in the dispersion relations give the non-relativistic Coulomb spectrum and the part of the fine structure that is due to

relative motion of the particles. Additionally, they give charged particle-anti-particle bound states, and give poles in the infrared singularity that are not cancelled by other terms of the amplitude. (D.C.W.)

**29538** THE ΛΛ-HYPERNUCLEUS AND THE Λ-Λ INTERACTION. R. H. Dalitz (Univ. of Chicago). Phys. Letters, 5: 53-6(June 1, 1963). (In English)

A Λ-Λ hypernucleus formed in a $\Xi^-$ capture event in emulsion was interpreted as $_{\Lambda\Lambda}Be^{10}$ with separation energy $B_{\Lambda\Lambda} = 17.5 \pm 0.5$ Mev relative to $\Lambda + \Lambda + Be^8$(g.s.). The shape, strength, and scattering properties of the potential representing the Λ-Λ interactions are examined. The Λ-N and Σ-N interactions are also considered in an effort to determine the coupling between channels. (D.C.W.)

**29539** SPIN-STATISTICS CONNECTION FOR STRANGE PARTICLES. R. Gatto (Università, Florence and C.N.E.N., Frascati, Italy). Phys. Letters, 5: 56-7(June 1, 1963). (In English)

Quantization of spin-zero and spin ½ fields with anticommutators and commutators, respectively, is shown to lead to violation of the postulates underlying the contention that particles with integral spin obey Bose statistics while particles with half-integral spin obey Fermi statistics. Drell speculated that K particles obey Fermi statistics while Λ particles obey Bose statistics. The hypothesis of anticommutation relations for the K field is shown to lead to forbiddenness for the $p + \bar{p} \rightarrow K + \bar{K}$ reaction while the assumption of commutation relations for the Λ field forbids the process $p + \bar{p} \rightarrow \Lambda + \bar{\Lambda}$ from s-states. (D.C.W.)

**29540** THE Λ-Λ INTERACTION. J. J. De Swart (CERN, Geneva). Phys. Letters, 5: 58-60(June 1, 1963). (In English)

Assuming that the Λ-Λ interaction can be described by pion exchange alone, the Λ-Λ, Λ-Σ, and Σ-Σ potentials are calculated. Values of the Λ-Σ coupling constant necessary to reproduce the Λ-Λ scattering length were also obtained, and the dependence of the Λ-Λ interaction on the Λ-Σ and Σ-Σ coupling constants was investigated. The origin and form of the potentials for Λ-Λ and Λ-N interactions are compared; the assumption of unitary symmetry and pseudoscalar coupling is noted to give a good fit to Λ-Λ and Λ-N scattering data. (D.C.W.)

**29541** FURTHER MEASUREMENTS OF THE $\pi^+ \rightarrow \pi^0 + e^+ + \nu$ DECAY RATE. P. Depommier, J. Heintze, C. Rubbia, and V. Soergel (CERN, Geneva). Phys. Letters, 5: 61-3(June 1, 1963). (In English)

Calculations based on 38 ± 2 additional events give a value for the branching ratio $R = \pi^+ \rightarrow \pi^0 + e^+ + \nu / \pi^+ \rightarrow \mu^+ + \nu$ of the process $\pi^+ \rightarrow \pi^0 + e^+ + \nu$ of $R_{exp} = (1.08 \pm 0.21) \times R_{cvc}$, where $R_{cvc}$ is the value predicted by the conserved vector current theory. Good agreement between experimental and theoretical coupling constants and weak anomalous magnetic moments supports the validity of the conserved vector current theory. (D.C.W.)

**29542** INVESTIGATION OF $Y_0^*$(1405) PRODUCTION BY $K^-$ AT REST IN EMULSION. A. Barbaro-Galtieri, F. M. Smith, and J. W. Patrick (Univ. of California, Berkeley). Phys. Letters, 5: 63-7(June 1, 1963). (UCRL-10641). (In English)

Emulsion stocks were exposed to a $K^-$ beam from the Bevatron. Momentum and mass distributions obtained in analysis of the events gave no evidence for a previously reported Σ-π resonant state in $C^{12}$ at 1405 Mev with a width of 1 Mev. The Σ-π mass spectrum for $K^-$ on $C^{12}$ showed an enhancement around 1412 Mev, but impulse model calculations show that it can be explained without an appeal to $Y_0^*$ (1405) production. (D.C.W.)

**29543** DETERMINATION OF THE REACTION RATE $\pi^-_{at\ rest} + p \rightarrow \pi^0 + n$ IN HYDROGENOUS MATERIALS. M. Chabre, P. Depommier, J. Heintze, and V. Soergel (CERN, Geneva). Phys. Letters, 5: 67-9(June 1, 1963). (In English)

The fraction of mesons($\pi^-$) stopped in hydrogenous materials that interacts with hydrogen nuclei by the process $\pi^- + p \rightarrow \pi^0 + n$ was determined for LiH, CH, and $CH_2$ by detecting coincidences between the $\pi^-$ and the two γ rays from $\pi^0$ decay. Measurements were also made with Li and C targets so the background could be subtracted. The values obtained are about three times as large as those obtained in other experiments. A value obtained for $H_2$ agrees well with expectations. (D.C.W.)

**29544** PARITY CLASS, EQUIVALENCE PRINCIPLE, AND THE MASS FORMULA FOR BARYONS AND RESONANCES. T. Takabayasi (Nagoya Univ., Japan). Phys. Letters, 5: 73-5(June 1, 1963). (In English)

Division of baryons and their resonances into two parity classes each governed by a unified mass formula in which the quantum number $\nu = J - \frac{1}{2} - Y$ (where J is the spin, Y the hypercharge) plays the role of mass number gives mass formulas completely specifying the mass spectra of the baryons and resonances. The formulas are based on an equivalence between an external quantum number $J - \frac{1}{2}$ and internal quantum number -Y that enter the mass number. The validity of the equivalence principle is demonstrated, and the accurate prediction of masses by the formulas is shown. (D.C.W.)

**29545** DIFFRACTION PEAKS AND HIGH ENERGY CROSS SECTIONS. E. Leader (Univ. of California, Berkeley). Phys. Letters, 5: 75-6(June 1, 1963). (UCRL-10753). (In English)

The previously obtained bounds for the width of the diffraction peak in elastic scattering are shown to be extremely coarse. The bounds relate the width to the behavior of the elastic and total cross sections. (D.C.W.)

**29546** INTERMEDIATE BOSON PRODUCTION BY NEUTRINOS. J. S. Bell and M. Veltman (CERN, Geneva). Phys. Letters, 5: 94-6(June 1, 1963). (In English)

The production, by neutrinos incident on nuclei, of the hypothetical intermediate bosons of weak interactions is considered. The treatment of Lee is modified in two ways. For the coherent process, more realistic nuclear form factors are adopted; and, in the incoherent process, the exclusion principle is allowed for. As a result, both contributions to the cross sections are substantially reduced. Total cross sections for Al and Cu were also computed and compared with Lee's prescriptions. (auth)

**29547** UNITARY SYMMETRY AND LEPTONIC DECAYS. Nicola Cabibbo (CERN, Geneva). Phys. Rev. Letters, 10: 531-3(June 15, 1963).

An analysis of leptonic decays based on unitary symmetry for strong interactions (eightfold way) and the V-A theory for weak interactions is presented. An explanation for the observed predominance of the $\Lambda \rightarrow p + e^- + \bar{\nu}$ decay over the $\Sigma^- \rightarrow n + e^- + \bar{\nu}$ decay is obtained. Branching ratios predicted for electron modes with $\Delta S = 1$ are presented; the ratios for the above decays agree well with experimental results. (D.C.W.)

**29548** EXPERIMENTAL EVIDENCE OF π-π SCATTERING NEAR THE ρ AND $f^0$ RESONANCES, FROM $\pi^- + p \rightarrow \pi + \pi +$ NUCLEON, AT 3 Bev/c. V. Hagopian and

W. Selove (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Letters, 10: 533-5(June 15, 1963).

Mass plots obtained for the $\pi^- - \pi^+$ and $\pi^- + \pi^0$ systems resulting from $\pi^-$-p interactions are presented, and the analysis of these and other data in terms of $\pi$-$\pi$ scattering is discussed. Evidence of a major contribution from the one-pion exchange mechanism (peripheral collision) for low nucleon recoil momentum was found. The spin of the $f^0$ is noted to be greater than zero, but no conclusion was drawn on whether it is 2 or greater than 2. The $\pi$-$\pi^0$ scattering in the $\rho$ region is consistent with a dominant p-wave resonance, and the $\pi^- - \pi^+$ data in this region have a strong forward-backward asymmetry. (D.C.W.)

**29549** ELASTIC SCATTERING OF GAMMA RAYS BY PROTONS. R. F. Stiening, E. Loh, and Martin Deutsch (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 10: 536-7(June 15, 1963).

Analysis of data obtained by detecting the interactions of gammas with protons in spark chambers gave the differential cross section at 90° for the process. The results agree with an isobar model calculation by Minami and indicate that the 90° scattering proceeds largely through the (1,3) isobar. The method of analysis is described. (D.C.W.)

**29550** RESONANCE STRUCTURE OF THE PION-NUCLEON SYSTEM. P. Carruthers (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 10: 538-9(June 15, 1963).

A mechanism giving rise to the spin-orbit forces that have been suggested to produce observed structure in the $\pi$-N cross section is proposed. The exchange of $D_{13}$ is shown to give repulsive forces $D_{33}$ and $D_{15}$ and a probable resonance in $D_{35}$. $F_{15}$ also gives rise to repulsive $F_{17}$ and $F_{35}$ forces and probably an $F_{37}$ resonance. The similarity in shape of the $\pi^- - p$ and $\pi^+ - p$ spectra can be understood on the basis of these forces. (D.C.W.)

**29551** DYNAMICAL BASIS FOR REGGE TRAJECTORIES IN THE PION–NUCLEON SYSTEM. P. Carruthers (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 10: 540-3(June 15, 1963).

Relations for the coupling between the various partial-wave amplitudes are derived, and the pairing of Regge trajectories through the action of exchange forces is considered. The effect of $P_{33}$ exchange on F states is examined, and quantum number assignments for maxima in $\pi^-$-p and $\pi^+$-p interactions are suggested on the basis of exchange considerations. (D.C.W.)

**29552** ELASTIC $\pi^+$ + p SCATTERING FROM 7 TO 17 Bev/c. K. J. Foley, S. J. Lindenbaum, W. A. Love, S. Ozaki, J. J. Russell, and L. C. L. Yuan (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 10: 543-6(June 15, 1963). (BNL-6993)

Differential cross sections obtained for the momentum range 7 to 17 Bev/c and the 4-momentum-transfer squared range of 0.2 to 0.1 $(\text{Bev/c})^2$ failed to show the shrinkage with increasing center-of-mass energy squared that was predicted by Regge-pole theory. Similar results were previously obtained for $\pi^-$-p scattering, while shrinkage was observed in p-p cross sections. These results contradict the dominance of the vacuum pole or three-pole models. (D.C.W.)

**29553** EXPERIMENTAL DETERMINATION OF THE NEUTRAL BRANCHING RATIOS OF THE $\eta$ MESON. Frank S. Crawford, Jr. and L. J. Lloyd (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 546-9(June 15, 1963). (UCRL-10809)

The decay of $\eta$ produced in a hydrogen bubble chamber by the reaction $\pi^+ + p \rightarrow \pi^+ + p + \eta$ with incident $\pi^+$ of 1170 Mev/c was studied. The existence of the decay mode $\eta \rightarrow \gamma + \gamma$ was confirmed and that of $\eta \rightarrow 3\pi^0$ was established. The branching ratios $\eta \rightarrow \gamma + \gamma/(\eta \rightarrow \pi^+ + \pi^- + \pi^0) + \eta \rightarrow (\pi^+ + \pi^- + \gamma)$, $\eta \rightarrow 3\pi^0/(\eta \rightarrow \pi^+ + \pi^- + \pi^0) + (\eta \rightarrow \pi^+ + \pi^- + \gamma)$, $\eta \rightarrow \pi^+ + \pi^- + \gamma/\eta \rightarrow \gamma + \gamma$, and $\eta \rightarrow 3\pi^0/\eta \rightarrow \pi^+ + \pi^- + \pi^0$ were determined to be $0.99 \pm 0.48$, $0.66 \pm 0.25$, $0.21 \pm 0.12$, and $0.83 \pm 0.32$, respectively. (D.C.W.)

**29554** ESSENTIAL SINGULARITY OF A PARTIAL-WAVE AMPLITUDE. Joseph V. Lepore and Robert J. Riddell, Jr. (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 550-1(June 15, 1963). (UCRL-10790)

A potential obtained by requiring that in Born approximation the potential reproduces that part of the scattering amplitude that arises from the third double spectral function of the Mandelstam representation is used to find Regge poles from the homogeneous part of the radial momentum-space Schrödinger equation for the elastic partial-wave amplitude. An infinity of solutions is found near the orbital angular momentum-1. (D.C.W.)

**29555** LEPTONIC HYPERON DECAYS AND UNITARY SYMMETRY. John M. Cornwall and Virendra Singh (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 10: 551-3(June 15, 1963).

Use of the unitary symmetry scheme (eightfold way) of Gell-Mann and Neeman is shown to resolve the discrepancy between experimental values of the branching ratios of $\Lambda$ and $\Sigma^-$ decays and values derived from V-A theory. The experimental values had been too low. Branching ratios are calculated and are shown to fit experimental data. Coupling constants for pions to baryons are calculated, and predictions on the leptonic decays of $\Xi$ particles are made. (D.C.W.)

**29556** TEST OF MASS SPECTRA. Richard L. Lander (Univ. of California, San Diego). Phys. Rev. Letters, 10: 553-5(June 15, 1963).

A mass spectrum recently predicted for elementary particles and resonances seemed to agree very well with experimental values. The spectrum has a constant interval between successive predicted masses. By determining the distribution of observed masses within this constant interval, the predicted spectrum is shown to have little experimental backing. (D.C.W.)

**29557** ON THE ENERGY DEGENERATION OF LATTICE ELECTRONS IN A MAGNETIC FIELD. H. J. Fischbeck (Deutschen Akademie der Wissenschaften, Berlin). Phys. Status Solidi, 3: 1082-8(1963). (In German)

From the circumstance, that the Hamiltonian of a Bloch electron in a magnetic field commutes with certain "gauge translation operators," conclusions concerning symmetry properties, quantum numbers, and degeneracy of the wave functions were drawn. The degeneracy of the wave functions was connected with a periodicity of their energy spectrum. (auth)

**29558** MASS DIFFERENCES OF MESONS AND BARYONS. Bronisław Średniawa (Jagiellion Univ., Krakow, Poland). Postepy Fiz., 14: 51-9(1963). (In Polish)

A continuation of a series of review articles on the mass differences of various mass multiplets of the baryon and meson group is presented. The Feynman-Dyson type of perturbation calculation was extended to mesons and baryons. The recent mass-difference calculations of T. Okui are discussed, and the method and results of this type of calculation are compared with those of O'Raifeartaigh, et al. It is pointed out that the local theory cannot,

in general, give a proper account of mass differences of elementary particles. Therefore, the nonlocal theory of Hutler and Arnous was used as a basis of the calculations of N. Straumann and of O'Raifeartaigh, et al. In spite of the apparent success of this theory in the area of mass differences, there remains an area of difficulty that relates to the magnetic moment of the electron. This difficulty, along with efforts to rectify it, are discussed in the light of the completeness of present-day modifications of field theory. (TTT)

**29559** INVERSE SCATTERING PROBLEM FOR ONE-DIMENSIONAL SCHROEDINGER EQUATION ALONG THE AXIS. V. Buslaev and V. Fomin. Vestn. Leningr. Univ., Ser. Mat., Mekhan. i Astron., No. 1, 56-64(1962). (In Russian)

The Schroedinger equation along the axis with the potential that tends to the different limits on the ends was considered. The S-matrix properties were studied for the scattering problem connected with this equation. It is proved that S-matrix may be restored through the refraction coefficient amplitude on the least limit side. The problem of the potential determination by S-matrix was solved. (auth)

**29560** VOPROSY FIZIKI ELEMENTRRNYKH CHASTITS. (Problems in Physics of Elementary Particles). A. I. Alikhanyan, ed. Erivan, Publishing House of the Academy of Sciences, 1962. 402p.

Lectures delivered at the second session of the Spring School of Experimental and Theoretical Physics are presented. Thirty-three papers on the resonances and asymptotics of strong interactions of elementary particles at high energies, properties of the meson ($\mu$), physics of the neutrino, and experiments in counter beams and electromagnetic interactions are included. (C.E.S.)

**29561** VOPROSY TEORII SIL'NYKH I SLABYKH VZAIMODEISTVII ELEMENTARNYKH CHASTITS. (Problems of the Theory of Strong and Weak Interactions of Elementary Particles). V. B. Berestetskogo, ed. Erivan, Publishing House of the Academy of Sciences, 1962. 192p.

Lectures delivered at the Spring School of Theoretical and Experimental Physics are presented. Fifteen papers on analyticity and unitarity of S-matrix theory, Feynman diagrams, Mandelstam representations, and the Sakata model are included. Three-particle interactions, the effects of coupling in meson ($\mu$) capture, and properties of the mesons ($K^0$), ($K_1^0$), and ($K_2^0$) are also discussed. (C.E.S.)

## Neutron Physics

*Refer also to abstract 29735.*

**29562** (AEEW-M-350) THE GENERALIZED HEAVY FREE GAS THERMALIZATION OPERATOR. H. H. W. Pitcher (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1963. 22p.

An introduction is given to the generalized heavy free gas (Horowitz) thermalization operator, which is a device for simplifying thermalization calculations. Analytical, experimental, and numerical methods for determining the energy-dependent function f in the operator are discussed. The dependence of f on the nature of the moderator, its temperature, and the absorption of the system are investigated, using a program FOCS which derives f's from DSN (multigroup) thermal spectra; it is found that for most purposes the dependence on absorption is negligible except when $Pu^{240}$ is present. The sensitivity of calculated spectra and reaction rate to changes in f is considered. The function f is given for graphite at 300 and 600°K. (auth)

**29563** (BRL-1199) NEUTRON REFLECTION AND FLUX VERSUS DEPTH FOR IRON. Frank J. Allen, Arnold Futterer, and William Wright (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Mar. 1963. 105p.

Detailed calculated results on neutron reflection and flux versus depth for iron are given in the form of machine printouts. The angular and energy distributions of the reflected neutrons along with the energy-dependent and total flux at various depths are contained in tabular form on the printouts. A table of information on reflection contains number current, number flux, dose, and energy reflection factors as functions of incident energy and angle. Figures are presented to illustrate graphically the meaning of the various tabular results. (auth)

**29564** (CNAM-7) DERIVATION DE L'EQUATION DE NORDHEIM A PARTIR DE L'EQUATION DE DIFFUSION. (Derivation of the Nordheim Equation from the Diffusion Equation). Ahmed Yueksel Oezemre (Turkey. Atomic Energy Commission. Çekmece Nuclear Research Center, Istanbul). 1963. 12p.

The Nordheim equation is deduced by basing the derivation only on the equation for the scattering of thermal neutrons by a multiplying medium. This is done by adding to the diffusion equation a source term that expresses conveniently the contribution of $\underline{m}$ different groups of delayed neutrons to the neutron balance of the medium. The consideration of a single differential equation in order to obtain the Nordheim equation evidently constitutes an important simplicity with respect to the method applied up to the present. This method consisted of using simultaneously the diffusion equation for thermal neutrons and of $\underline{m}$ coupled equations giving the densities of nuclei-mothers, fission products emitting delayed neutrons. (tr-auth)

**29565** (IDO-16856) MIST (MULTIGROUP INTERNUCLEAR SLAB TRANSPORT). G. E. Putnam and D. M. Shapiro (Internuclear Co., Inc., Clayton, Mo.). May 10, 1963. For Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho. Contract AT(10-1)-205; Subcontract C-222. 104p.

MIST, a set of codes designed to solve the one-dimensional Boltzmann transport equation in slab geometry for up to six energy groups, 250 space points and 40 regions, is described. The MIST program uses the $S_n$ approximation to the Boltzmann equation, but is rapidly convergent for all one-dimensional reactor systems. Theory, input, and output are discussed; and the FORTRAN listing is included along with sample input and output listings. (auth)

**29566** (WAPD-T-1563) P-3 MULTIGROUP CALCULATIONS OF NEUTRON ATTENUATION. K. Shure (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). May 1963. Contract AT(11-1)-Gen-14. 21p.

A multigroup P-3 approximation for calculating spatial-spectral neutron distributions in metal-hydrogenous reactor shields is described. Parameters used to solve the group equations are obtained from basic microscopic cross section data. The thermal neutron flux and fast neutron spectra calculated for a point fission source in all water agree fairly well with the experimental thermal flux and rigorously calculated fast neutron spectra. Calculations are also in good agreement with thermal neutron flux measurements through Fe–$H_2O$ shields except within thick iron regions. In thick iron shields a multigroup thermal

treatment gives better calculational and experimental agreement. (auth)

**29567** (WAPD-T-1577) A STABLE AND NON-ITERATIVE SOLUTION TO THE DISCRETE ORDINATES EQUATIONS. E. Schmidt (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Apr. 1963. Contract AT-11-1-GEN-14. 10p.

A procedure for obtaining non-iterative and stable solutions to the discrete ordinates equations approximating the one-dimensional transport equation is described. The system of equations is transformed into a set of coupled matrix equations identical in form to the P1 equations. An appropriate substitution gives equations for three variables that can be solved non-iteratively. The case of slab geometry is particularly examined. The solution as discussed has been programmed in FORTRAN. (D.C.W.)

**29568** NEUTRONS ON DEMAND. Kenneth W. Erickson and Barney J. Carr (Kaman Aircraft Corp., Colorado Springs, Colo.). Ind. Research, 5: 36-41(June 1963).

The production of neutrons by small positive ion accelerators that are optimized for nuclear reactions involving isotopes of hydrogen is discussed. The reactions deuteron–deuterium and deuteron–tritium produce 2.5 and 14 Mev neutrons, respectively. The efficiency of several different ion sources is discussed. The Van de Graaff accelerator and methods using r-f fields, central force fields, and magnetic mirror systems are considered. (C.E.S.)

**29569** ELEMENTARY SOLUTION OF THE TRANSPORT EQUATION WITH ANISOTROPIC SCATTERING. Hans Hejtmanek (Osterreichische Hochschule, Vienna). Nukleonik, 5: 173-8(June 1963). (In German)

The Boltzmann equation in the neutron transport theory was solved for the case of anisotropic scattering with the help of the Case theory. The scattering nucleus was approximated by means of a polynomial of arbitrary arrangement. (tr-auth)

**29570** THE ENERGY DISTRIBUTION OF NEUTRONS FROM A Po-$\alpha$-Be SOURCE. D. Haag and H. Fuchs (Universität, Heidelberg). Z. Physik, 174: 227-30(1963). (In German)

The neutrons from a Po-$\alpha$-Be source were detected via the recoil protons in a stilbene scintillator. The pulse-height spectrum of the scintillations produced in the stilbene crystal by the recoil protons was analyzed to yield the incident neutron energy distribution. The $\gamma$ background was eliminated through pulse shape discrimination. Separately the spectrum of neutrons coincident with $\gamma$ rays, i.e., of neutrons from the $Be^9(\alpha,n)C^{12*}$ reaction, was determined. The resulting spectra are compared to previous measurements. The structure of the spectra is not compatible with an isotropic angular distribution of the neutrons relative to the $\alpha$-direction. Furthermore it could be shown that the fraction of reactions leading to the 7.65 Mev state of $C^{12}$ is only about $10^{-3}$. (auth)

## Nuclear Properties and Reactions

*Refer also to abstract 29202.*

**29571** (INS-R-19) A COMPUTER PROGRAM FOR ANALYSIS OF DATA ON THE ELASTIC SCATTERING OF ALPHA PARTICLES BY OXYGEN$^{16}$. G. Pallo (New Zealand. Inst. of Nuclear Sciences, Lower Hutt). May 1963. 12p.

The program compares an experimental angular distribution with the angular distribution calculated from a set of phase shifts. A mesh of phase shifts is studied, and from the $X^2$ calculated for each mesh point minima are selected. These minima in $X^2$ provide starting points for least squares analyses of the data to derive phase shifts; these parameters completely determine the scattering. The program was written in Fortran II for an IBM 1620 machine that results in a computer time of approximately 65 seconds per cycle, after the initializing cycle of 50 seconds. (auth)

**29572** (KR-44) MEASUREMENT OF RESONANCE ABSORPTION IN $U^{238}$ USING A CHEMICAL SEPARATION TECHNIQUE FOR ISOLATION OF $Np^{239}$. J. Thomassen and H. H. Windsor (Norway. Institutt for Atomenergi, Kjeller). Mar. 1963. 37p.

A simple method of accurate quantitative chemical separation of neptunium from small foils of reactor fuel materials was developed. This was used for the measurement of $\rho_{28}$ by an indirect method that avoids the introduction of cadmium into the reactor cell under study but relies on an auxiliary irradiation of a fuel foil in a pure thermal neutron flux together with dysprosium foils for normalization purposes. A detailed description of the irradiation and chemical procedures is given together with results obtained in some lattices investigated. A method of normalization by means of residual fission products rather than by dysprosium foils is described. (auth)

**29573** (LAL-1049) DIFFUSION INELASTIQUE DES ELECTRONS DE HAUTE ENERGIE ET REGLES DE SOMMATION SUR L'OXYGENE 16. (Inelastic Scattering of High Energy Electrons and Sum Rules for Oxygen-16). C. Betourne, D. Isabelle, and G. R. Bishop (Paris. Université, Orsay. École Normale Supérieure. Laboratoire de l'Accélerateur Linéaire). Mar. 1963. 47p.

The inelastic scattering of 100- to 200-Mev electrons by $O^{16}$ is studied. The emission of zero, one, or more nucleons is taken into account. Excitation energies below about 90 Mev are considered. Several sets of sum rules for this scattering process are compared with the experimental results. (T.F.H.)

**29574** (NYO-10562) OBSERVATION OF RADIATIVE CAPTURE OF MUONS IN COPPER. William T. Chu (Carnegie Inst. of Tech., Pittsburgh). Jan. 1963. Contract AT(30-1)-882. 124p.

The radiative capture of negative muons by a complex nucleus, $\mu^- + \text{Nucleus} \rightarrow \text{Nucleus}' + \text{neutrino} + \text{photon}$, was observed for muons stopping in Cu. Events were identified visually using a spark chamber with copper plates to detect the stopping muons and a spark chamber with lead plates to detect the pair resulting from conversion of the associated photon. The energy of the photon was deduced from the pulse produced by the pair in a large NaI crystal. Counter pulses displayed on a fast oscilloscope gave information on the time distribution of events. For approximately $3 \times 10^8$ $\mu$-stops, 100 good events were observed. Extraction of the branching ratio R of radiative capture to the ordinary capture depends upon detailed assumptions about the internal excitation of the final nucleus following the muon capture. However, the dependence is not very strong and the overall average branching ratio is $R = (5.5 \pm 1.8) \times 10^{-4}$. The result is larger than would be expected theoretically for a pure V–A coupling and is consistent with an estimate that includes an additional pseudoscalar interaction in the four Fermion coupling of muon and neutrino to proton and neutron. 39 references. (auth)

**29575** (PAN-242) ZAGADNIENIA MODELU OPTYCZNEGO DLA DEUTERONOW. (Problem of the Optical

Model for Deuterons). K. Grotowski (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). 1963. 51p.

Problems concerning parameters of the optical potential for deuterons are presented. Total cross-sections for the interaction of deuterons with nuclei were determined by the evaluation of the cross-sections for the emission of charged particles and neutrons. The angular distributions for the elastic scattering of deuterons were also measured. 47 references. (auth)

**29576** (PAN-410/IX) NEKOTORYE ISSLEDOVANIYA SVYAZANNYE S IZMERENIYAMI NEITRONYKH SECHENII POGLOSHCHENIYA NA REAKTORE EWA METODOM REAKTORNOGO OSTSILLYATORA). (Some Experiments on Absorption Cross Section Determination by the Pile Oscillator Method in the EWA Reactor). J. Bouzyk (Yatsek Bouzhyk), Witold Suwalski (Vitol'd Suval'ski), and Jerzy Topa (Ezhi Topa) (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Mar. 1963. 17p.

Presented at Conference on Physics and Reactor Technology, Prague, April 1963.

Further development of the measurements (i.e., investigation of various states and shapes of the samples as well as the self-screening in the samples) is described. Considerable gain in sensitivity and accuracy was obtained by reducing the diameter of the measuring channel. The water layer surrounding this channel brought about softening of the neutron spectrum in the channel. Slowing-down effect of the light elements was investigated. Absorption cross sections of some elements were measured with the accuracy within 5%. The results obtained indicate the possibility of neutron cross section measurements, at least for elements with weak resonance absorption. (auth)

**29577** (UCRL-7063) THE SCATTERING OF ALPHA PARTICLES BY CARBON, OXYGEN, MAGNESIUM, AND GOLD. H. F. Lutz, J. B. Mason, and C. T. Paulson (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 1, 1962. Contract W-7405-eng-48. 17p.

Differential cross sections for the scattering of alpha particles by C, O, Mg, and Au at 60° in the laboratory system were measured over the energy range 13 to 30 Mev. All curves exhibit fluctuations from the smooth behavior predicted by the optical model. In the case of Au, it is shown that the optical model gives the average behavior of the differential cross section. 43 references. (auth)

**29578** IODINE SOURCE FOR HALF-LIFE EXPERIMENTS. Frank L. Moore, Jr. (Clarkson Coll. of Tech., Potsdam, N. Y.). Am. J. Phys., 31: 362-3(May 1963).

Sodium iodate is a very satisfactory material for half life experiments. The single stable isotope of iodine has a neutron capture cross section of 6 barns. The radioisotope has a half life of 25 min allowing counting over several half lives in a laboratory period. With two hour irradiation the 15-h sodium activity is negligible, whereas with long irradiation, the sources are suitable for a mixed decay experiment. (auth)

**29579** PHOTON AND ELECTRON HIGH-ENERGY PHYSICS: PRESENT AND FUTURE. W. K. H. Panofsky (Stanford Univ., Calif.). Am. J. Phys., 31: 409-16(June 1963).

The area of high-energy physics to which electron and photon beams from accelerators have made important contributions was discussed. Processes that explore an unknown or poorly known structure, such as a nucleon or an artificially produced particle, with the known action of electromagnetism, processes in which artificial unstable particles are created by electrons or photons where the presence of a bombarding particle that possesses strong interaction would complicate analysis, and experiments that attempt to extend the range of the square of the four-momentum transfer, over which quantum electrodynamics is known to be valid, were described. (C.E.S.)

**29580** THE RATIO OF THE INDEPENDENT FORMATION CROSS SECTIONS OF THE ISOMERIC STATES OF $Cs^{134}$ IN THE PROTON-INDUCED FISSION OF URANIUM. J. H. Davies and L. Yaffe (McGill Univ., Montreal). Can. J. Chem., 41: 1836-7(July 1963).

In the study of nuclear charge dispersion in the fission of natural U by high-energy protons, data were collected on the independent yields of Cs isotopes. The ratio of the cross section for $Cs^{134m}$ formation to that for $Cs^{134g}$ was calculated and is plotted against proton energy over the range 30 to 80 Mev. The metastable state is favored, especially at the lower energies. (D.L.C.)

**29581** SINGLE-NUCLEON MODEL OF NUCLEUS. [PART] II. V. Lelek and I. Ulehla (Czech. Tech. Univ., Prague). Czech. J. Phys., 13: 311-17(1963). (In English)

The relativistic equations of motion of a single-nucleon model of the atomic nucleus are solved. The nucleon moves in a central field which is given by a mixture of scalar, pseudo-vector and pseudo-scalar coupling. A comparison between the results and experiment and between the results and the non-relativistic theory of the shell model shows that the relativistic theory offers practically as much as the non-relativistic theory, although it differs both in the formal and physical aspects. (auth)

**29582** CIRCULAR POLARIZATION OF INTERNAL BREMSSTRAHLUNG IN UNIQUE FIRST FORBIDDEN BETA TRANSITIONS. F. Janouch (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., 13: 394-6(1963). (In English)

The degree of circular polarization of internal bremsstrahlung quanta accompanying unique first forbidden beta transitions is calculated in the Born approximation using the conventional methods for V-A interaction. Only rough agreement is obtained with experimental data for the ($\Delta J$ = 2, yes) transition in $Y^{90}$, probably due to inapplicability of the Born approximation to the $Y^{90}$ nucleus. (D.C.W.)

**29583** MEASUREMENT OF ANGULAR DISTRIBUTION OF PROTONS FROM $Al^{27}(p,p')Al^{27}$. J. Křemének (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Prague), M. Skřivánková, and J. Šimková. Czech. J. Phys., 13: 396-8(1963). (In English)

The angular distribution of elastically scattered protons and five groups of inelastically scattered protons from Al was measured in a range of 30-170° at an incident proton energy of 6.5 Mev. The measured groups correspond to $-Q$ = 0.842, 1.015, 2.21, 2.73, 2.98, and 3.00 Mev; the last two groups were not resolved. A Si surface barrier detector with a resistivity of 1700 Ω–cm was used in the measurements. The results confirm the strong dependence of the angular distribution on incident proton energy and agree well with data for elastically scattered protons. (auth)

**29584** G-NONCONSERVING TERMS IN THE BETA DECAY INTERACTION. B. Eman and D. Tadić. Glasnik Mat.-Fiz. Astron., Ser. II, 17: 81-7(1962). (In English)

The possibility of the existence of G nonconserving terms in the beta decay interaction Hamiltonian is discussed. The known experimental material about allowed transitions indicates that there is negligible if any contribution of such terms. (auth)

**29585** AN APPROXIMATION FOR THE ABSORPTION IN QUASI-ELASTIC SCATTERING OF PROTONS ON LIGHT NUCLEI. Janez Strnad. Glasnik Mat.-Fiz. Astron., Ser. II, 17: 89-106(1962). (In German)

Equations are given for the approximation of absorption in proton scattering on light nuclei. (M.C.G.)

**29586** CROSS SECTIONS INDUCED BY 11 Mev PROTONS. J. Olkowsky (CEN, Saclay, France), N. Cindro, and P. Strohal. Glasnik Mat. Fiz. Astron., Ser. II, 17: 117-22(1962). (In English)

Measurements of total reaction cross sections were performed by the activation method in the external beam of an 11.2-Mev proton cyclotron. The following cross sections were determined: 151 mb for $Y^{89}(p,n)Zr^{89m}$, 234 mb for $Y^{89}(p,n)Zr^{89g}$, 83 mb for $Y^{89}(p,n)Zr^{89g}$, 205 mb for $Mo^{94}(p,n)Tc^{99}$, 53 mb for $Mo^{94}(p,d)Mo^{93m}$, 116 mb for $Mo^{100}(p,2p)Tc^{99m}$, and 16.2 mb for $Mo^{100}(p,\alpha)Nb^{97}$. Q-values for the investigated reactions are given. (M.C.G.)

**29587** HALF-LIFE OF $^{85}$Kr. J. Lerner (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 25: 749-57 (July 1963). (In English)

The half life of $Kr^{85}$ was measured by observing the decay of the 0.7-Mev $\beta$ activity over a period of ten years, yielding the value 10.76 years. This is somewhat higher than all of the values previously recorded in the literature. Accuracy of the method and possible sources of systematic error are discussed. (auth)

**29588** DETERMINATION OF THE ABSORPTION AND SCATTERING CROSS SECTIONS OF RARE GASES FOR THERMAL NEUTRONS. R. Genin, H. Beil, C. Signarbieux, P. Carlos, R. Joly, and M. Ribrag (CEN, Saclay). J. Phys., 24: 21-6(Jan. 1963). (In French)

The total cross section of rare gases as a function of neutron energy in a range between $3 \times 10^{-3}$ to $25 \times 10^{-3}$ ev was measured. For these elements the law of total cross-section variation can be interpreted and this permits the determination of absorption and scattering cross sections. (auth)

**29589** SPIN AND PARITY OF THE EXCITED LEVELS AT 8.926 AND 8.988 Mev of $O^{15}$. J. Cohen-Ganouna, M. Lambert, and J. Schmouker (École Polytechnique, Paris). J. Phys., 24: 43-54(Jan. 1963). (In French)

Differential cross sections for the elastic scattering of protons from $N^{14}$ were measured for several scattering angles and for laboratory proton energies between 1 and 2 Mev. These data were analyzed in terms of the single-level approximation of the dispersion theory. The results yield the following resonance energies (Mev) and very probable assignments of spin and parity for two levels of the compound nucleus $O^{15}$: 1.743 ($5/2^+$) and 1.809 ($5/2^-$). (auth)

**29590** (p,3p3n) REACTIONS BETWEEN 30 AND 150 Mev. G. Albouy, J. P. Cohen, M. Gusakow, N. Poffé, H. Sergolle, and L. Valentin (Faculté des Sciences, Orsay, France). J. Phys., 24: 67-8(Jan. 1963). (In French)

Reactions (p,3p3n) on $O^{16}$, $V^{51}$, $Nb^{93}$, and $Au^{197}$ were studied at energies between 30 and 150 Mev using the internal beam of the Orsay synchrocyclotron with irradiation times from 5 min to 1 hr. The Au and Nb were chemically separated. The activity of each of the isotopes formed by the (p,3p3n) reaction was measured on a characteristic $\gamma$ radiation. The excitation functions obtained are represented graphically. In all cases these excitation functions show the emission of $\alpha$ particles since the reactions are produced below the thresholds calculated for the emission of free nucleons. The mass number affects the shape of the excitation function, which has a maximum between 40 and 50 Mev for the light nuclei and then decreases steadily. For medium elements the more or less pronounced maximum at about 50 Mev is followed by a decrease and then an increase beginning at about 70 to 80 Mev. In the case of Au, the excitation function seems to increase after the threshold up to 150 Mev. (J.S.R.)

**29591** NUCLEAR MAGNETIC MOMENTS OF PLUTONIUM-239 AND 241. C. Berthelot (Bureau Central de Mesures Nucléaires, Geel, Belg.). J. Phys., 24: 69-70 (Jan. 1963). (In French)

The nuclear magnetic moments calculated from the factor $\alpha_{7/2} = 0.364$ cm$^{-1}$ are $\mu(Pu^{239}) = 0.207 \pm 0.033$ and $\mu(Pu^{241}) = 0.73 \pm 0.12$ nuclear magnetons. The same calculation applied to the magnetic interval factors determined by L. A. Korostyleva gives different values. The $^6F_{5/2}$ and $^6F_{7/2}$ terms yield too weak a separation. The mean value of the magnetic interaction constant deduced from the Gerstenkorn and Champeau experimental results, is $\alpha_{7/2} = 307 \pm 40$ mK. Therefore, the probable values of the nuclear magnetic moments are $\mu(Pu^{239}) = 0.175 \pm 0.040$ and $\mu(Pu^{241}) = 0.62 \pm 0.15$ nuclear magnetons. The uncertainty of the results is caused principally by measurements of the hyperfine structure. (J.S.R.)

**29592** THE MÖSSBAUER EFFECT IN THIN FILMS. A. Corciovei and A. Berinde (Inst. of Atomic Physics, Bucharest). J. Phys., 24: 89-98(Feb. 1963). (In French)

A theoretical study of the Mössbauer effect in thin films is given. The obtained recoilless emission rate, the so-called Debye-Waller factor, has the form: $f(q) = f(\infty)^{c(q)[1+D(q)\cos^2\theta]}$, where $f(\infty)$ is the value of the Debye-Waller factor which corresponds to the bulk medium, c(q) and D(q) are functions that depend on the number q of monoatomic layers of the thin film, and $\theta$ is the angle between the direction of emission of the radiation and the normal to the thin film. The dependence of the anisotropy coefficient D versus q is studied for various values of the elastic forces in the lattice. The energy shift of the recoilless emitted quantum, due to the mass modification of the radiating nucleus is obtained and the result is compared with the corresponding energy shift for the bulk medium. (auth)

**29593** STUDY OF THE PROPERTIES AND OF THE EMISSION MECHANISM OF HYPERFRAGMENTS PRODUCED BY PROTONS AT 25 Bev/c IN THE NUCLEI OF IONOGRAPHIC EMULSIONS. G. Baumann, H. Braun, and P. Cüer (Centre de Recherches Nucleaires, Strasbourg). J. Phys., 24: 103-7(Feb. 1963). (In French)

The hyperfragments produced in interactions of 25 Bev/c protons are studied. The non-mesic decomposition of hyperfragments is investigated with particular attention in order to study the mechanism of their disintegration. The mechanism of hyperfragment emission seems to be similar to that of ordinary heavy ions. (auth)

**29594** HALF LIFE OF THE 217-kev EXCITED LEVEL OF $Hf^{179}$. M. Vergnes (Faculte des Sciences, Orsay, France). J. Phys., 24: 131-3(Feb. 1963). (In French)

The half life of the 217-kev excited level in $Hf^{179}$ was measured with a time-to-amplitude converter: $T_{1/2} = 1.5 \pm 0.15 \times 10^{-9}$ s. The probability of the 217-kev $E_1$ transition is compared with the probability of the 321-kev $E_1$ transition in $Hf^{177}$, and with the theoretical probabilities calculated from the Nilsson model. There is a considerable difference between the probabilities of the two $E_1$ transitions. (auth)

**29595** THE TEMPERATURE DEPENDENCE OF THE NUCLEAR MAGNETIC RESONANCE OF $Co^{59}$. Richard

Conley La Force, Louis E. Toth, and S. Frederick Ravitz (Univ. of California, Berkeley). J. Phys. Chem. Solids, 24: 729-33(June 1963). (In English)

The temperature dependence of the nuclear magnetic resonance spectrum of pure cobalt from 25 to 600°C was re-examined with the aid of more sensitive apparatus. The resonances from the hexagonal phase disappear at 490°C on heating and re-appear at 440°C on cooling. The principal resonance lines of the face-centered-cubic and hexagonal phases start to split into two lines each at about 235 and 260°C, respectively; the fractional splitting increases with temperature, and is approximately the same for the two phases. The absolute intensities of the split resonance decrease in an externally applied magnetic field, but the relative intensities are independent of the external field. (auth)

**29596** MEASUREMENT OF THE PERMEABILITY OF A PALLADIUM PROBE FOR NEUTRONS IN THE ENERGY REGION 1.5 TO 10 Mev. G. Richter, W. Biel, and E. Bagge (Universität, Kiel). Naturwissenschaften, 50: 397-8(1963). (In German)

The permeability of 99.965% pure palladium by neutrons was investigated and results are shown in graph form. Minima were observed in the permeability curve at the following neutron energies: 33.5 ± 1.5, 26.0 ± 1.0, 13.1 ± 0.4, 4.89 ± 0.1, and 2.95 ± 0.06 ev. (M.C.G.)

**29597** THE $B^{10}(d,\alpha)Be^8$ REACTION AND THE 2.94 Mev STATE IN $Be^8$. K. H. Purser and B. H. Wildenthal (Univ. of Kansas, Lawrence). Nucl. Phys., 44: 22-33(June 1963). (In English)

Alpha particles from the reaction $B^{10}(d,\alpha)Be^8$ were observed with solid state particle detectors and a 256-channel pulse-height analyser. The differential cross section of the reaction was measured at 156° in the laboratory system. For the reaction channel leading to the ground state of $Be^8$, the differential cross section increased steadily from approximately 0.28 to 0.39 mb/sr over the deuteron energy range from 1.0 to 1.8 Mev. Over the same energy range the differential cross section for the reaction channel leading to the 2.94 Mev, first excited state of $Be^8$ increased from 2.62 mb/sr to a maximum of 5.54 mb/sr at $E_d$ = 1.6 Mev and then decreased to 4.88 mb/sr. Angular distributions of the particle groups leading to both the ground and first excited states of $Be^8$ were measured at five energies in the range $E_d$ = 1.0 to 1.8 Mev. Forward peaking with an energy dependent second maximum at approximately 115° was observed. For the ground state transition, total cross sections are 7.5, 7.2, 6.75, 9.2, and 9.3 mb at deuteron energies of 1.0, 1.2, 1.46, 1.59, and 1.75 Mev, respectively. The cross sections for the transition to the first excited state at the same deuteron energies are 50, 59, 61, 71, and 60 mb, respectively. A careful search for possible even parity, even spin states of $Be^8$ was made in the range of 1-7 Mev excitation energy in $Be^8$. No evidence for states other than the 2.94-Mev, $2^+$ state was found. The line shape of the 2.94-Mev state was obtained with a coincidence technique. Theoretical fits of this shape were made with the Wigner-Eisenbud formalism. The results seem to indicate that, in the energy range studied, the interaction radius of two $\alpha$ particles is comparatively large, i.e., from 5 to 6 fm. (auth)

**29598** PHOTONUCLEAR REACTION (γ,np) AND NUCLEON-NUCLEON CORRELATIONS IN LIGHT NUCLEI. T. I. Kopaleishvili and R. I. Jibuti (Tbilisi State Univ., USSR). Nucl. Phys., 44: 34-43(June 1963). (In English)

The photonuclear reaction (γ,np) on light nuclei is considered on the model of independent pairs in order to obtain information about nucleon-nucleon correlations in the nucleus. A general expression for the effective cross section for the process under study is obtained. The $O^{16}(\gamma,np)$ and $N^{14}(\gamma,np)$ reactions are used to illustrate the fact that the energy dependence of the total cross section and distribution over the relative energies of the emitted nucleons are sensitive to changes of the parameters of the wave function of the correlated pair in the nucleus. The role of the four-nucleon correlations on the nucleus $O^{16}$ is discussed for the process under study. The theory is compared with available experimental data. (auth)

**29599** STRENGTH FUNCTIONS FOR NUCLEI WITH COLLECTIVE COORDINATES. Izumi Furuoya (Tokyo Inst. of Tech.) and Atsushi Sugie. Nucl. Phys., 44: 44-57(June 1963). (In English)

The s-wave strength function was calculated for nuclei in the so called vibrational region using both Davydov et al.'s rigid ellipsoidal model and A. Bohr's vibrational model. Both models predict triple peaks at a giant resonance corresponding to spherical, non-vibrating nuclei. The second $2^+$ level of these models, which is observed experimentally very often, is as important as the first $2^+$ level although the former couples indirectly with the ground state. (auth)

**29600** EXCITED ENERGY LEVELS IN $Dy^{160}$. W. Michaelis (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys., 44: 78-92(June 1963). (In English)

The transitions and levels of $Dy^{160}$ populated by $Tb^{160}$ beta decay were investigated by the methods of sum coincidence, gamma-gamma coincidence, angular correlation, and polarization-direction correlation. The results confirm the decay shceme proposed by G. T. Ewan et al., which differs in the negative parity levels from the schemes reported by others. The relative intensities of the gamma rays and the quadrupole admixtures of several transitions are given. (auth)

**29601** SIMPLIFIED SHELL-MODEL CALCULATIONS OF ALPHA DECAY RATE NEAR $Pb^{208}$. John O. Rasmussen (Univ. of California, Berkeley). Nucl. Phys., 44: 93-106 (June 1963). (In English)

Simplified formulas approximating the shell-model theoretical results of Mang and Harada are derived and tested. Numerical calculations of alpha reduced widths from ground and excited states of $Po^{212}$ are made using wave functions of Band, Sliv, and Kharitonov. The calculated reduced widths for decay from $Po^{212}$ excited states are lower than the width from ground state by factors ranging from 4 to 7 except that the second excited $2^+$ state shows a very small width. The usual analyses of long-range alpha intensities to derive excited state lifetimes must be modified, making the lifetime estimates longer by the appropriate hindrance factor. (auth)

**29602** PROTONS FROM $^{32}S$ BOMBARDED BY 14.6 Mev NEUTRONS. B. Antolkovic (Inst. "Ruder Boskovic", Zagreb). Nucl. Phys., 44: 123-9(June 1963). (In English)

Protons from 14.6 Mev neutron induced reactions on $S^{32}$ were studied. The proton energy and angular distributions are consistent with the statistical model predictions and from the shapes of the distributions the level density parameters were derived. A small contribution only from a direct interaction of incident neutrons with protons was found. The cross sections for the reactions involved were determined and compared to the existing data. (auth)

**29603** THE 936 AND 1261 kev RESONANCES IN THE $^{27}Al(p,\gamma)^{28}Si$ REACTION AND THE PROPERTIES OF THE 6.88 Mev DOUBLET STATE IN $^{28}Si$. R. Nordhagen (Uni-

versitetet Oslo). Nucl. Phys., 44: 130-50(June 1963). (In English)

Gamma-ray spectra, branching ratios, and gamma-ray yields were measured for the resonances at 926 and 1261 kev in the $Al^{27}(p,\gamma)Si^{28}$ reaction. Information on the decay of one of the two excited states at 6.88 Mev in $Si^{28}$ is obtained. The analysis of angular correlation and distribution measurements on prominent cascades leads to spin assignments $J^{\pi} = 3^{-}$ for the two resonant levels at 12.48 and 12.80 Mev excitation energy. A spin J = 2 is indicated for the 6.88-Mev excited state decaying with a strong ground state transition. The experimental evidence suggests a controversial odd parity assignment to the same 6.88-Mev state. The γ transition from the 12.80 resonant level to the first excited state of $Si^{28}$ at 1.78 Mev shows a clear M2/E1 multipole mixing. The M2 transition strength is found to be close to the Weisskopf estimate. (auth)

**29604** STATISTICAL MECHANICS OF A SUPERFLUID NUCLEAR MATTER. I. NUCLEAR LEVEL DENSITY. P. Brovetto and V. Canuto (Instituto Nazionale di Fisica Nucleare, Turin). Nucl. Phys., 44: 151-63(June 1963). (In English)

The statistical properties of nuclei are studied. The framework is a paper by S. T. Belyaev in which an actual assembly of nucleons with interaction is transformed into a new one composed of free quasi-particles. The main feature is the appearance of an energy gap Δ. Limited to an infinite nuclear matter, a new expression for the level density is given. A lowering of the nuclear level density by a factor that reaches the value of 10 is obtained. The value of Δ was taken as 1 Mev. (auth)

**29605** THE DECAY SCHEME OF $Ru^{95}$. Peter Riehs and Hans Warhanek (Inst. for Radium Research and Nuclear Physics, Vienna). Nucl. Phys., 44: 164-72(June 1963). (In German)

The beta and gamma activity of $Ru^{95}$ was investigated by coincidence spectrometry using NaI(Tl) crystals and anthracene crystals. Gamma lines at 340, 625, 1090, and 1430 kev were found, some of them in agreement with earlier work. A new decay scheme is suggested on the basis of coincidence and intensity measurements. (auth)

**29606** METHOD FOR THE USE OF FISSION OF $U^{238}$ AND $Th^{232}$ BY FAST NEUTRONS FOR THE MEASUREMENT OF NEUTRON FLUX. Wilfried Koehler and Jean Romanos (Technische Hochschule, Munich). Nukleonik, 5: 159-63(June 1963). (In German)

For the proposed method foils of fissionable material were covered with so-called "collector foils" (aluminum or polyethylene). The calibration of three foils followed on the basis of a known fission rate of $U^{235}$ and by absolute determination of the β activity during use of the known regularity of the number of β particles per fission depending on the waiting time. A comparison of the flux value measured with $U^{238}$ or $Th^{232}$ with the values from other threshold value detectors (sulfur and phosphorus) resulted in disagreement within the limits of error. (tr-auth)

**29607** UNSTABLE FRAGMENT EMISSION FROM 25 Gev/c PROTON STARS IN NUCLEAR EMULSION. I. R. Kenyon, A. W. Key, and S. Lokanathan (Oxford Univ.). Nuovo Cimento (10), 28: 873-84(June 1, 1963). (In English)

The heavy prongs from 8,000 25 Bev proton interactions in Ilford G5 emulsions giving 4 or more heavy prongs were followed in the pellicle containing the primary interaction and all secondary interactions recorded. 379 secondary interactions were found including 129 hammer tracks, 6 mesonic hyperfragments, and 5 definite nonmesonic hyperfragments. The range spectrum of connecting tracks of other secondary stars shows a marked peaking below 50 microns. Statistical arguments are used to show that there are 26 unidentified nonmesonic hyperfragments with connecting track less than 50 microns. The hyperfragment production rate is ~ 0.5% and the hammer track production rate is ~ 1.6% for the star sample scanned. An attempt is made to interpret the rise from lower bombarding energies of the former rate. An isotropic angular distribution of the hammer tracks is found and the energy spectrum fits the evaporation model with parameters T = 12 and V = 0 Mev. Possible explanations of these features are discussed. (auth)

**29608** FAST HELIUM NUCLEI EMITTED FROM HIGH-ENERGY NUCLEAR DISINTEGRATIONS. M. Yasin (Regional Engineering Coll., Srinagar, India). Nuovo Cimento (10), 28: 935-42(June 1, 1963). (In English)

Secondary helium nuclei having energies between 80 and 500 Mev emitted from cosmic-ray disintegration were studied. Mass measurements of these particles indicate that the majority of them are $He^3$. The differential energy spectra of secondary tritons and helium nuclei are found to be identical. The star-size distributions for stars emitting tritons and helium nuclei are also similar. These observations indicate that the mechanism of emission of tritons and helium nuclei is the same. (auth)

**29609** THE REACTION $^7Be(n,\alpha)^4He$ AND PARITY CONSERVATION IN STRONG INTERACTIONS. P. Bassi (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna), B. Ferretti, G. Venturini, G. C. Bertolini, F. Cappellani, V. Mandl, G. B. Restelli, and A. Rota. Nuovo Cimento (10), 28: 1049-65(June 1, 1963). (In English)

The reactions $Be^7(n,\alpha)He^4$ and $Be^7(n,\gamma\alpha)He^4$, produced by thermal neutrons were studied. An upper limit for the first of the two, $\sigma_1 \leq 0.1$ mb, was established. For the second one $\sigma_2 = 155$ mb. The limit for $\sigma_1$, in the hypothesis of $(2^-)$ attribution to the 18.9-Mev level of $Be^8$, corresponds to $F^2 \leq 4.10^{-10}$, where F is the ratio of the amplitudes of the opposite parity wave functions. This result is used to put an upper limit to the strength of a possible parity-violating interaction involving strange particles. (auth)

**29610** MAGNETIC DIPOLE TRANSITIONS AND POLARIZATION OF PHOTONEUTRONS FROM $Be^9$. J. Sawicki (Istituto Nazionale di Fisica Nucleare, Bologna and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 28: 1098-1100(June 1, 1963). (In English)

Using a pure j-j spherical shell model of beryllium-9, the photoneutron polarization for unpolarized γ rays is obtained from the E1 + M1 magnetic dipole transition approximation. The result is compared with recent experiment and theoretical models. (C.E.S.)

**29611** ELECTRIC QUADRUPOLE INTERACTION IN Hf METAL AT DIFFERENT TEMPERATURES. M. Salomon, L. Bostroem, T. Lindqvist, and Martha Perez (Univ. of Uppsala). Phys. Letters, 5: 13-14(June 1, 1963). (In English)

The temperature dependence of the differential anisotropy as a function of time was measured for the 133-482-kev cascade in $Ta^{181}$ that resulted from $Hf^{181}$ activity obtained by neutron irradiation of Hf metal. Results indicate that the electric quadrupole interaction frequency depends on the temperature (integral anisotropies and interaction frequencies are given). The deviation from the Abragam and Pound theory (observed and elsewhere) was also found to be invariant with temperature. (D.C.W.)

**29612** THE SPINS OF THE SECOND, THIRD AND FOURTH EXCITED STATES IN $Ca^{40}$. H. P. Leenhouts and P. M. Endt (Rijksuniversiteit, Utrecht). Phys. Letters, 5: 69-70(June 1, 1963). (In English)

Analysis of angular correlation measurements on the reaction $K^{39}(p,\gamma)Ca^{40}$ with 3-Mev protons gave spin values of J = 3, 2, and 5 for the second, third, and fourth excited states in $Ca^{40}$. (D.C.W.)

**29613** Si(n,p)Al AND Si(n,$\alpha$)Mg REACTIONS IN THE NEUTRON ENERGY RANGE OF 6-9 Mev. G. Andersson-Lindstroem (Institut für Experimentalphysik, Hamburg) and E. Roessle. Phys. Letters, 5: 71-2(June 1, 1963). (In English)

The cross sections of the reactions $Si^{28}(n,\alpha)Mg^{25}$, $Si^{28}(n,p)Al^{28}$, and $Si^{29}(n,\alpha)Mg^{26}$ were measured in the neutron energy range of 6 to 9 Mev by bombarding a Si solid state detector with neutrons from the D(d,n)$He^3$ reaction. The excitation functions show fluctuations in accord with Ericson's prediction for the overlapping level region of the compound nucleus for small beam-energy spread. (D.C.W.)

**29614** WIDTHS OF FLUCTUATIONS IN NUCLEAR CROSS SECTIONS. D. M. Brink and R. O. Stephen (Clarendon Lab., Oxford). Phys. Letters, 5: 77-9(June 1, 1963). (In English)

At high energies cross section resonances due to states of compound nuclei in nuclear reactions overlap, and the partial reaction cross sections fluctuate as a function of energy. Ericson's formulas for the probability distribution of a partial cross section $\sigma$ are obtained. Additionally, relations for the average number of maxima in the cross section per unit energy and for the probability distribution of $d\sigma/dE$ are derived. (D.C.W.)

**29615** FURTHER EXPERIMENTAL EVIDENCE FOR A THREE PARTICLE CONFIGURATION IN $V^{51}$. J. Vervier (Centre d'Etude de l'Energie Nucléaire, Mol). Phys. Letters, 5: 79-82(June 1, 1963). (In English)

Predictions by the core particle coupling model and the three particles configuration model of the low-lying states in $V^{51}$ are compared with experimental data on electric quadrupole moments, magnetic dipole moments, and transition probabilities. Only the transition data permit a choice between the two models; a three particles configuration in $V^{51}$ is favored. (D.C.W.)

**29616** APPLICATION TO THE EXACT THEORY OF THE PAIRING MODEL TO SOME EVEN ISOTOPES OF LEAD. R. W. Richardson (Univ. of Michigan, Ann Arbor). Phys. Letters, 5: 82-4(June 1, 1963). (In English)

Results of using the exact eigenstates of the pairing-force Hamiltonian in the pairing models of $Pb^{202}$, $Pb^{204}$, and $Pb^{206}$ are reported. With these eigenstates a pairing-interaction strength about 30% stronger than that previously used was found desirable. This stronger pairing interaction plus the exact theory of the pairing model predicts the observed pairing energies, within the experimental errors, and the excitation spectra (excluding the lowest $2^+$ states), with an average error of 0.09 Mev. (auth)

**29617** MESIC HYPERFRAGMENTS PRODUCED IN THE INTERACTIONS OF $\pi^-$-MESONS AT 17.2 Gev/c WITH THE NUCLEI OF IONOGRAPHIC EMULSIONS. G. Baumann, H. Braun, and P. Cueer (Centre de Recherches Nucléaires, Strasbourg). Phys. Letters, 5: 85-7 (June 1, 1963). (In French)

Thirty-five of the 168 hyperfragments produced in Ilford G5 emulsion exposed to 17.2-Bev/c mesons ($\pi^-$) exhibited mesic decay. The different decay modes and their binding energies were calculated. The distributions of the hyperfragments as functions of track length, charge, and number of branches were similar to those obtained in interactions of 25-Bev protons and of 1.5-Bev/c $K^-$. Maxima in the last two distributions occurred for Z = 2 and 3, respectively. Several of the hyperfragments had charge Z > 4, and the existence of the $He^6$ hyperfragment was apparently confirmed. The event ${}_{\Lambda}B^{12} \rightarrow C^{12} + \pi^-$ gave $C^{12}$ in the ground state. A study of the angular distribution of the hyperfragments ruled out an evaporation mechanism for their production. (D.C.W.)

**29618** THE ISOTOPIC SPIN DEPENDENCE OF THE NUCLEAR OPTICAL MODEL POTENTIAL. J. Dabrowski and A. Sobiczewski (Inst. for Nuclear Research, Warsaw). Phys. Letters, 5: 87-8(June 1, 1963). (In English)

The (p,n) reaction can be described by the isotopic-spin dependent optical potential $V = V_0 + V_1 A^{-1} tT$, where t,T are the isotopic spin operators of the scattered nucleon and the target nucleus. Formulas for $V_0$ and $V_1$ as functions of N-N phase shifts can be derived from scattering amplitudes. These formulas and the new Yale phase shifts were used to calculate $V_0$ and $V_1$. $ReV_1$ was found to be $\lesssim 40$ Mev for scattered nucleon energies $E_0 \gtrsim 0$ and $\lesssim 100$ Mev; for $E_0 \gtrsim 200$ Mev, $ReV_1$ is less than zero. For $E_0 \gtrsim 50$ Mev, $ImV_1 \cong 20$ Mev. Difficulties in estimating the magnitude of $V_1$ from proton scattering are mentioned. (D.C.W.)

**29619** BRANCHING RATIO AND WIDTH OF THE 2.98 Mev LEVEL OF $Al^{27}$. V. J. Vanhuyse, G. J. Vanpraet, and K. J. Van Camp (Rijksuniversiteit, Ghent). Phys. Letters, 5: 89-90(June 1, 1963). (In English)

The width of the 2.98-Mev ($^3/_2^+$) level of $Al^{27}$ was measured using a self-absorption method. Al was used for the target and absorber, while Mg was used as a dummy scatterer. Photons produced by 3.65-Mev electrons on the target were detected by a NaI(Tl) crystal after passing through a Pb absorber. Comparison of transmission values with curves of the transmission computed as a function of total width for different values of the total width and partial width for transition to ground state gave the total width as a function of total width/partial width. The value obtained for the ratio of partial width/total width disagreed sharply with Van der Leun's value. (D.C.W.)

**29620** ANGULAR DISTRIBUTIONS OF THE REACTION $O^{16}(t,p)O^{18}$. B. Kuehn (Zentralinstitut für Kernphysik, Dresden) and B. Schlenk. Phys. Letters, 5: 91(June 1, 1963). (In English)

The angular distributions of protons from the reaction $O^{16}(t,p)O^{18}$ at 665, 900, 1087, and 1400 kev were measured. The angular distributions as a function of energy change their form significantly. The curves are not symmetric about 90°, and at 900 and 1087 kev the differential cross sections display two significant minimums. For the four energies the excitation energies of the $F^{19}$ compound nucleus are 12.25, 12.45, 12.61, and 12.87 Mev. Only one strong resonance was found at 12.87 Mev, partly overlapped by the 13.30-Mev resonance. Accordingly, the angular distributions change their form between 1087 and 1400 kev energies. (auth)

**29621** DETERMINATION OF THE EFFECTIVE CROSS SECTION FOR FORMATION OF THE STABLE ISOTOPE $Na^{23}$ OF SODIUM IN THE REACTION $Al^{27}(p,3p2n)Na^{23}$ AT 155 Mev. Nguyen-Long-Den and M. Borot (Institut du Radium, Orsay, France). Phys. Letters, 5: 92-3(June 1, 1963). (In French)

The effective cross section for the production of $Na^{23}$ in the reaction $Al^{27}(p,3p2n)Na^{23}$ at 155 Mev was determined by mass spectrometry. Pure Al samples were irradiated

and subjected to processes to fix the Na, which was extracted and placed on the thermionic emission filament of the spectrometer. From relations between the ratio of the number of $Na^{22}$ and $Na^{23}$ atoms, the mass of the sample, $Na^{22}$ activity, and the ratio of $Na^{23}$ and $Na^{22}$ cross sections, the cross section for $Na^{23}$ production was found to be about 23 mb. (D.C.W.)

**29622** ISOTOPE SHIFT AND SATURATION BEHAVIOR OF THE 1.15-$\mu$ TRANSITION OF Ne. A. Szoeke and A. Javan (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 10: 521-4(June 15, 1963).

The dependence of a laser's power output and exact oscillation frequency dependence on the saturation behavior of the atomic transition was used to study the transition. Two He–Ne lasers containing isotopically enriched samples of $Ne^{20}$ and $Ne^{22}$ were used. From frequency considerations, the isotope shift was determined to be 261 ± 3 Mc/sec at 0.1 mm Ne and 1.0 mm He partial pressures. Extrapolation from a plot of the saturation parameters vs total He–Ne pressure gave limits for the parameters of $10^6$ $sec^{-1}$. (D.C.W.)

**29623** WIDTHS OF NUCLEAR SINGLE-PARTICLE BOUND STATES. P. A. Moldauer (Argonne National Lab., Ill.). Phys. Rev. Letters, 10: 525-6(June 15, 1963).

A relation between the widths and the imaginary part of the optical-model potential used to describe such states is derived. Analysis of the relation shows that width measurements can help determine the rearrangement energy and the spatial distribution of the imaginary part of the potential. Previously obtained experimental results are explained. (D.C.W.)

**29624** PHOTODISINTEGRATION OF $He^3$. B. L. Berman, L. J. Koester, Jr., and J. H. Smith (Univ. of Illinois, Urbana). Phys. Rev. Letters, 10: 527-9(June 15, 1963).

The 90° differential cross sections for the $He^3(\gamma,p)d$ photodisintegration were measured for photon energies of 8.5 to 22 Mev. Total cross sections calculated from the differential cross sections did not agree with cross sections based on Gaussian or pure exponential wave functions for $He^3$. Irving's wave function with an appropriate size parameter gave a good fit to the data. The rms nuclear radius calculated with this function agreed well with experimental results while a calculated nuclear form factor was too large. The photodisintegration cross section apparently is very sensitive to nuclear size. (D.C.W.)

**29625** (p,2p) ANGULAR CORRELATIONS IN THE DISTORTED-WAVE BORN APPROXIMATION. K. L. Lim and I. E. McCarthy (Univ. of Adelaide). Phys. Rev. Letters, 10: 529-31(June 15, 1963).

A distorted-wave Born approximation calculation of the (p,2p) angular correlation for 155-Mev protons on $C^{12}$ was performed to examine the effect of various parameters on the calculated curves. The effect of the radius of the struck proton was quite different from the effects of optical-model parameters; therefore the radius can be accurately determined independently of the optical model. Effects of other parameters are discussed, and a distorted-wave analysis is concluded to determine the single-particle wave functions very well. (D.C.W.)

**29626** DISTORTED WAVE ANALYSIS OF THE REACTION $^{12}C(d,n)^{13}N(GS)$. P. E. Hodgson (Nuclear Physics Lab., Oxford). Proc. Phys. Soc. (London), 81: 977-85 (June 1, 1963).

The data of Elwyn, Kane, Ofer, and Wilkinson for incident deuteron energies from 1.45 to 2.95 Mev are analysed using the distorted-wave Born approximation. The overall features of the measured differential cross sections are accounted for, and the possibility of using such analyses to obtain information on the optical potentials is discussed. (auth)

**29627** THE MÖSSBAUER EFFECT IN IRON ALLOYS. C. E. Johnson, M. S. Ridout, and T. E. Cranshaw (Atomic Energy Research and Establishment, Harwell, Berks, Eng.). Proc. Phys. Soc. (London), 81: 1079-90(June 1, 1963).

Alloys of iron with cobalt, nickel, vanadium, chromium, manganese, aluminium, and silicon were studied using the Mössbauer effect. In ferromagnetic alloys the variation of hyperfine field at $Fe^{57}$ nuclei with electron concentration is qualitatively similar to that of the saturation magnetic moment of the alloys. Owing to the lack of information concerning the relation between the spin density at the nucleus and the spin density in the environment, a more quantitative relation with the individual magnetic moments of the iron and solute atoms cannot be derived at present. In atomically disordered alloys the line broadening, which measures the extent of the fluctuations in hyperfine field, depended upon the difference between the iron and solute atomic moments; in ordered alloys the lines were not broadened. Several of the non-ferromagnetic alloys showed magnetic ordering at low temperatures. (auth)

**29628** THORIUM IRRADIATION WITH BREMSSTRAHLUNG. Eiko Nakamura (Japan Atomic Energy Research Inst., Tokyo). Radiochim. Acta, 1: 66-7(Jan. 1963). (In English)

Thorium oxide was bombarded with bremsstrahlung from the linear accelerator in JAERI. After bombardement thorium was chemically purified from fission products. Measurement of decay and $\beta$ and $\gamma$ spectra proved that $Th^{231}$, produced through $(\gamma,n)$ nuclear reaction, was obtained with a high radioactive purity. (auth)

**29629** DETECTION OF SHORT-LIVED FISSION-PRODUCT MOLYBDENUM AND DECAY TO ITS TECHNETIUM DAUGHTER. III. DECAY SERIES: $Mo^{103}$–$Tc^{103}$–$Ru^{103}$. P. Kienle, (Technische Hochschule, Munich), F. Baumgaertner, B. Weckermann, and U. Zahn. Radiochim. Acta, 1: 84-5(Jan. 1963). (In German)

The assignment of the previously unknown decay of $Mo^{103}$ was accomplished following a fast chemical separation of molybdenum from fission products of uranium. $Mo^{103}$ decays with a half life of (70 ± 10) sec to $Tc^{103}$. An activity with a half life of (50 ± 5) sec could be definitively attributed to the decay of $Tc^{103}$. Its $\beta$ decay was followed by $\gamma$ rays of 135 kev, 215 kev, and 350 kev. (auth)

**29630** PREPARATION AND DECAY OF $^{72}Zn$. A. Kjelberg (Univ. of Oslo), E. Hageboe, and R. Nordhagen. Radiochim. Acta, 1: 156-7(June 1963). (In English)

A radiochemical method for separation of essentially carrier-free zinc from uranium or thorium and their fission products was worked out and applied to the study of the decay of $Zn^{72}$. Gamma transitions of energies 15, 42, 46, 78, 103, 112, 144, and 190 kev were found. (auth)

**29631** OPTICAL MODEL FOR CROSS-SECTIONS OF RADIATIVE CAPTURE AND INELASTIC NEUTRON SCATTERING. Yu. P. Elagin and P. E. Nemirovskii (Inst. of Atomic Energy, Moscow). Ukr. Fiz. Zh., 8: 418-25(1963). (In Ukrainian)

An optical model was used for the calculation of cross-sections of radiative capture and inelastic neutron scattering with excitation of low-lying levels. A satisfactory agreement with experiment is obtained. (auth)

**29632** GENERALIZED MODEL OF THE NUCLEUS AND SOME QUESTIONS OF $\beta$-DECAY THEORY. A. A. Kresnin (Inst. of Physics and Tech., Khar'kov). Ukr. Fiz. Zh., 8: 426-30(1963). (In Ukrainian)

On the basis of a generalized model of the nucleus the values of the relative period of $\beta$ decay for some types of the $\beta$ decay of light nuclei are calculated. A comparison is made with experiment confirming the applicability of the generalized model to a description of the properties of light nuclei. (auth)

**29633** DETERMINATION OF THE CHARGE DENSITY OF LIGHT NUCLEI BY A GENERALIZED MODEL. B. I. Tishchenko (Inst. of Physics and Tech., Khar'kov). Ukr. Fiz. Zh., 8: 431-9(1963). (In Ukrainian)

A method is given for determining the charge density of light nuclei by a generalized model. It is assumed that the nucleons move in a deformed axisymmetrical potential and their interaction is accounted for by this potential. In this case the charge density of the nucleus is the sum of densities created by separate nucleons. The expression obtained for the charge density is expanded into a series by Legendre polynomials. The first two coefficients of this expansion determine the mean square radius and quadrupole moment of the nucleus, respectively. Formulas are presented to obtain these values readily for nuclei with $Z \leq 20$. (auth)

**29634** THE DECAY OF $Co^{60m}$ AND $Zr^{90m}$. W.-D. Schmidt-Ott (Universität, Gottingen, Ger.). Z. Physik, 174: 206-21(1963). (In German)

$Co^{60m}$ was produced by the reaction $Co^{59}(n,\gamma)Co^{60m}$. Its decay was investigated by scintillation spectrometers. The half life was remeasured yielding a value of $T_{1/2} = (10.35 \pm 0.20)$ min. The isomeric decay mainly led to the $Co^{60}$ ground state by a $(58.6 \pm 0.6)$ kev transition. The K-conversion coefficient $\alpha_K = 41 \pm 3$ and the total conversion coefficient $\alpha = 47 \pm 3$ indicated the transition to be M3 and the spin of $Co^{60m}$ to be $2^+$. $Co^{60m}$ also decays by beta transitions to $Ni^{60}$. The beta component $(8.6 \pm 1.2) \times 10^{-3}$%, log ft = 7.32 leading to a $(2.16 \pm 0.02)$ Mev level was measured for the first time. A second component $(0.24 \pm 0.03)$%, log ft = 7.23 led to the 1.33 Mev level. The 2.16-Mev level decayed to the $Ni^{60}$ ground state mainly by a 0.83-1.33 cascade, in a few cases by a direct transition. The spin of the 2.16 Mev level is $2^+$. $Zr^{90m}$ was produced by the reaction $Zr^{90}(n,n')Zr^{90m}$. The half life was measured yielding a value of $T_{1/2} = (0.83 \pm 0.03)$ sec. $Zr^{90m}$ decayed in the following way: $(77 \pm 5)$% by a direct $(2.31 \pm 0.02)$ Mev-E5 transition to the Zr ground state and $(23 \pm 5)$% by a $(132.5 \pm 1.5)$ kev - $(2.18 \pm 0.03)$ Mev cascade detected for the first time in the isomeric decay. The K-conversion coefficient of the 132.5 kev transition was $\alpha_K = (2.2 \pm 0.3)$ indicating this transition to be E3 and the spin of the 2.18-Mev level to be $2^+$. The $Zr^{90m}$ decay scheme is in accordance with the level sequence of $Zr^{90}$ as measured in the $Nb^{90}$ decay. (auth)

**29635** THE ANGULAR DEPENDENCE OF THE ENERGY LOSS OF 1-Mev ELECTRONS BY BREMSSTRAHLUNG. A. Febel and G. Knop (Universität, Bonn). Z. Physik, 174: 257-68(1963). (In German)

The angular dependence of bremsstrahlung energy loss of 1-Mev electrons was measured at 30, 60, and 90°. The electrons were scattered on aluminum, silver, and gold foils of thickness from 0.1 to 2.3 mg/cm$^2$. The shape of the energy loss distribution between 20 and 100 kev was found in accordance with theory which gives $d^2\sigma/dQd\Omega = q_{Mott} \cdot c(E_0,\vartheta_0)/Q \cdot F$ where F is nearly 1. The experimental values of $c(E_0,\vartheta_0)$ agree with the theoretical ones within an error of ±3%. (auth)

**29636** THE ISOBARIC TRIAD (Ca, Sc, Ti)$^{42}$. John David Oberholtzer. Tallahassee, Florida State Univ., 1962. 132p.

An experimental study of the isobaric triad (Ca, Sc, Ti)$^{42}$ is presented. Using a Van de Graaff accelerator, the reactions $K^{39}(\alpha,n)Sc^{42}$, $Ca^{40}(He^3,p)Sc^{42}$, and $Ca^{40}(He^3,n)Ti^{42}$ were investigated. A comparison to theoretical predictions was made. Experimental techniques and equipment are described. The excitation curves for the $K^{39}(\alpha,n)Sc^{42}$ reaction are presented. The ground state threshold gave a Q value of $-7.455 \pm .045$ Mev for the reaction. From this, the mass excess of $Sc^{42}$ was calculated to be $-31.989 \pm 0.050$ Mev. The half life of this ground state was found to be $0.65 \pm 0.01$ sec and to decay by positron emission with maximum energy $5.525 \pm 0.50$ Mev. Log ft = 3.42 for the decay, indicating a superallowed character. A second threshold occurred in the excitation curve of this reaction at $8.800 \pm 0.020$ Mev. Positron activity was found from this state also. A half life of $60.6 \pm 0.4$ sec was measured with the maximum positron energy equal to $2.82 \pm 0.04$ Mev. Log ft = 4.09, thus indicating an allowed decay. Gamma spectra in coincidence with the allowed decay showed three energy peaks at 0.43, 1.21, and 1.51 Mev. A positron activity with a half life of $0.25 \pm 0.04$ sec and a maximum energy of approximately 6.0 Mev was detected in the reaction $Ca^{40}(He^3,x)$. By elimination, this activity was assigned to $Ti^{42}$. From the maximum positron energy the mass excess of $Ti^{42}$ is calculated to be -25 Mev, and the threshold for the $Ca^{40}(He^3,n)Ti^{42}$ reaction is found to be -3.10 Mev. Regularities in odd-odd, N = Z nuclei as $Sc^{42}$ are discussed. (Dissertation Abstr.)

**29637** YADERNYE REAKTSII PRI MALYKH I SREDNIKH ENERGIYAKH. TRUDY VTOROI VSESOYUZNOI KONFERENTSII. (Nuclear Reactions for Low and Medium Energies. Proceedings of Second All-Union Conference). Moscow, Publishing House of the Academy of Sciences, 1962. 658p.

Conference papers on nuclear reactions at low and medium energies are presented. Ninety-eight papers on low-nucleon systems, direct nuclear reactions, nuclear reactions with charged particles, neutrons, and heavy ions, photonuclear reactions, radiation capture reactions, and nuclear models are included. (C.E.S.)

## Particle Accelerators

**29638** (BNL-7091) STORAGE RINGS FOR ULTRA-HIGH ENERGIES. E. D. Courant (Brookhaven National Lab., Upton, N. Y.). May 14, 1963. Contract [AT(30-2)-Gen-16]. 34p.

Storage rings (150-1000 Bev) are shown to be capable of supplying energies comparable to those of the most energetic cosmic particles. The cost, design, size, probable beam intensities and interaction rates, and uses of a 300-Bev ring are examined. A 300-Bev ring is estimated to cost 50% more than a corresponding accelerator, to provide higher current densities and interaction rates than smaller rings, and to present no insurmountable construction problems. Small-angle scattering experiments at angles of a few milliradians seem feasible. (D.C.W.)

**29639** (CERN-63-16) A FORTRAN PROGRAMME FOR THE NUMERICAL ANALYSIS OF CURVILINEAR ELECTRODE SYSTEMS WITH AN EMITTING SURFACE. P. T. Kirstein and J. S. Hornsby (European Organization for Nuclear Research, Geneva). Apr. 25, 1963. 43p.

A computer program, written for an IBM 709, for ana-

lyzing an axially symmetric or two dimensional electrode system with an emitting surface is described. The program is easy to use, and performs in one pass the steps which were previously followed on analog and digital devices separately. The program alternately solves Poisson's equation by a relaxation technique, traces trajectories, recomputes the space-charge distribution, and again performs a relaxation process. This procedure continues until satisfactory convergence is achieved. The program, its input, and its output are described in detail. (auth)

**29640** (LAL-1050) LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE RAPPORT D'ACTIVITE (1er JUILLET 1962–1er AVRIL 1963). (Linear Accelerator Laboratory Report of Activities (July 1, 1962–April 1, 1963)). (Paris. Université, Orsay. École Normale Supérieure. Laboratoire de l'Accélerateur Lineaire). May 21, 1963. 41p.

The studies made at the Orsay Linear Accelerator Laboratory are reported. The Laboratory sections reporting work are accelerator operation, particle physics, hot chemistry, electronics, magnets, radiation control, and biological effects of radiation. A bibliographic tabulation of reports of completed studies is appended. (J.S.R.)

**29641** (NIRL/R/26) COMPUTER PROGRAMS USED TO PRODUCE A CORRECTED (ISOCHRONIZED) MAGNETIC FIELD FOR A VARIABLE ENERGY CYCLOTRON. D. A. Harragan and A. R. Mayhook (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). Feb. 1963. 27p.

To assist with the design of the variable-energy cyclotron to be built at Harwell, a set of computer programs was assembled. Those described consist of programs associated with the analysis of the measured field data and the subsequent computation of the optimum trim coil currents to produce the required isochronous field for a given ion. Some of the programs were obtained from the Lawrence Radiation Laboratory, University of California; operating instructions for these programs are given. A full list of complementary programs is included. (auth)

**29642** (NIRL/R/27) COMPUTER PROGRAMS FOR FINDING CLOSED ORBITS AND STUDYING PARTICLE MOTION IN A VARIABLE ENERGY CYCLOTRON. D. A. Harragan (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). Feb. 1963. 21p.

An account is given of a set of FORTRAN sub-programs designed to be complementary to programs written to produce isochronous magnetic fields. The programs described concern the location of equilibrium orbits and the subsequent studies of particle motion in a variable energy cyclotron. The input to these programs is reasonably variable but the routines can easily be recompiled if greater flexibility is desired. (auth)

**29643** (SLAC-16) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, January 1 to March 31, 1963. (Stanford Univ., Calif. Stanford Linear Accelerator Center). May 1963. Contract AT(04-3)-400. 100p.

Developments and research in the two-mile accelerator project are reported. Areas included are accelerator structure and klystron development and testing, modulator studies (particularly triggers), microwave engineering, beam focusing studies, control and instrumentation, and research on magnets, shielding, reactions, and other related topics. Operation and development of the Mark IV accelerator are also summarized. (D.C.W.)

**29644** (UCRL-10654) ELECTRICAL DESIGN OF ELECTROSTATIC DEFLECTORS FOR SECTOR-FOCUSED CYCLOTRONS. Bob H. Smith and Hermann A. Grunder (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 25, 1963. Contract W-7405-eng-48. 34p.

Considerations in the design of the deflectors are discussed, and the results of experiments on vacuum sparking and electrode materials are reviewed. Results obtained with a test-model deflector (described) are also presented along with a proposed deflector design. Tests reveal that metal septums may have to be used since carbon septums produce contamination. However, electrostatic deflectors perform very well in sector-focused cyclotrons of intermediate energies. Deflector efficiencies of about 50% and external-beam intensities of 20 μamp have been obtained. (D.C.W.)

**29645** (UCRL-10655) DEFLECTOR POWER SUPPLY FOR SECTOR-FOCUSED CYCLOTRONS. Bob H. Smith (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 25, 1963. Contract W-7405-eng-48. 28p.

Because of the higher particle energy, sector-focused cyclotrons require higher gradients in their electrostatic deflectors than ordinary cyclotrons. A higher operating gradient can be achieved by exciting the deflector from a low-energy-storage power supply that permits control of the electrode surface heating during each spark. A pair of high-frequency Cockcroft-Walton rectifiers with this capability was built for the Lawrence Radiation Laboratory's 88-Inch Cyclotron. Each rectifier consists of a six-stage circuit designed to deliver 120 kv at 5 mamp. It is driven by a 100-kc oscillator. The rectifier is built from inexpensive silicon diodes, each with a rating of 600 piV, 0.75 amp, and a storage time of 2 μsec. The diodes are assembled on etched circuit boards. Between decks of the rectifier, 900-pf, 30-kv ceramic capacitors similar to those in television sets are used. The dc output voltage is controlled by plate modulation of the oscillator and regulated to 0.01% by an electronic regulator. The rectifier is protected against spark-induced surge currents by an electronic crowbar operating on the screen grid of the oscillator. (auth)

**29646** HELICITY AND TRANSVERSE PULSE OF AN EXTREMELY RELATIVISTIC FERMION IN A CIRCULAR ACCELERATOR. Olivier Costa de Beauregard. Compt. Rend., 256: 4608-10(May 27, 1963). (In French)

It was admitted (Compt. rend., 256: 3978(1963)) that a particle with spin describing, in a magnetic field with fixed direction and with axial symmetry, a circular trajectory with constant velocity near c possesses two spin states tangent to the trajectory. The possibility of verifying in this manner the existence of "the inertial effect of spin" was suggested (Phys. Rev., 129: 466(1963)). A method for the separation of the two states of helicity of a particle in a circular accelerator, based on this effect if it exists, was also proposed. The exact Dirac solutions were constructed for the extreme relativistic case. The results perfectly verify the general predictions and constitute a very strong argument in favor of the existence of a spin-connected transverse pulse and of the concomitant inertial effect. (tr-auth)

**29647** THE ION OPTICAL SYSTEM OF A 200kv COCKCROFT-WALTON ACCELERATOR. N. Stipčić, M. Paić, and P. Tomaš (Institut "Rudjer Boskovic." Zagreb). Glasnik Mat.-Fiz. Astron., Ser. II, 17: 107-12 (1962). (In English)

The electrostatic lens geometry and voltages for the Cockcroft-Walton 200-kv accelerator were chosen by calculating the cardinal points. To achieve the stability of the beam, the lenses were shaped in such a manner that

accelerated ions could not reach the ceramic insulator of the accelerating tube from any point of their path. Acceleration and focusing were performed by means of four lenses formed by five cylindrical electrodes partly entering each other. For determination of the potential distribution the experimental method of the electrolytic plotting tank was used. In order to investigate ion motion, a graphical method for approximated path construction was used in combination with analogous measurements of the equipotential surfaces. Measurements were made of the size of the beam spot. (M.C.G.)

**29648** BETATRON. Stefan Nowicki, Józef Janiczek, and Robert Kiełsznia. Przeglad Elektron., 4: 178-89 (1963). (In Polish)

The theory of betatron design is surveyed, and the state-of-the-art of mapping time-varying magnetic fields is discussed along with the direct application of these measurements to the determination of the location of the stable orbit, of the optimum point of injection, and proper injection time and injection voltage. The required measuring precision for determining magnetic field conditions of stability is derived. Along with the discussion on the theory and measuring techniques for stable-orbit conditions, the regulation of the location of the stable orbit is included. A discussion of the theory of capture of electrons in the stable-orbit is given. A qualitative description of the techniques of extracting the electron beam is included. (TTT)

**29649** INVESTIGATION OF THE INTERFERING RADIATION AROUND A BETATRON DURING IRRADIATION WITH FAST ELECTRONS. Piero G. Paleani Vettori and Francesco Pigorini. Strahlentherapie, 121: 6-21(May 1963). (In German)

Dose measurements made in the environment of a 15-Mev-Betatron during irradiation with fast electrons are reported. The influence of scattered radiation measured ionometrically was investigated in regard to the type, distribution in the environment of the radiation field, and absorption by a phantom at different distances from certain points of the betatron capsule. It was assumed that the observed scattered radiation is caused by the electrons that hit the wall of the acceleration tube and not by the scattering of the released electrons. Finally, the importance of the results in regard to radiation protection is discussed. (P.C.H.)

**29650** AN APPROXIMATE ANALYTICAL METHOD FOR CALCULATING THE PHASE-ENERGY DISTRIBUTION OF ELECTRONS IN A LINEAR ELECTRON ACCELERATOR WITH $\beta_B = 1$. N. M. Gavrilov and A. V. Shal'nov. p.39-43 of "Uskoriteli. No. 3." Moscow, Gosatomizdat, 1962.

An approximate analytical method is given for calculating the phase-energy distribution of electrons in a linear electron accelerator with $\beta_B = 1$. It is shown that existing analytical techniques are inapplicable for obtaining the output characteristics of the accelerated beam. In order to assess the accuracy of the proposed method, the phase-energy distributions were taken for two accelerators with energies of 10 and 30 Mev, and satisfactory agreement was obtained with the values calculated from the approximate formula and using numerical integration. A certain divergence is explained. It is pointed out that a relatively large divergence between the energy values obtained by numerical integration and from the approximate formula has no material effect on the form of the output energy spectrum. Graphs are given and explained for the phase-energy distribution at the output of the 10 and 30 Mev accelerators. (OTS)

**29651** SELF-EXITED h.f-GENERATOR FOR A CYCLOTRON WITH AMPLITUDE CONTROL. Hans-Helmut Feldmann (to Licentia Patent-Verwaltungs-GmbH). German Patent 1,146,211. Mar. 28, 1963. Filed June 22, 1961.

A self-exited h-f generator is given which is provided with an auxiliary generator for stabilizing the amplitude in case of multipacting. This separate auxiliary h-f generator is controlled in such a way that the succession of the various control and switching procedures necessary for starting and operating the generator is performed automatically and the h-f amplitude is stabilized during normal operation. A detailed description of the generator is given. (Gmelin Inst.)

**29652** FIXED-FREQUENCY CYCLOTRON. Hans-Helmut Feldmann (to Licentia Patent-Verwaltungs-GmbH). German Patent 1,146,601. Apr. 4, 1963. Filed Aug. 10, 1961.

The fixed-frequency cyclotron described is provided with additional magnetic fields located along the orbits of the particles, the strength of which varies automatically according to the phase shift between the accelerating voltage and the circulating particles so that this phase shift is reduced to a negligible value. The additional magnetic fields can be generated by additional windings and are preferably arranged concentrically to the center of the cyclotron. With the help of these additional magnetic fields a satisfactory focusing of the orbiting particles is achieved even when the main magnetic field deviates considerably from its required strength and when working with low accelerating voltages and therefore low current losses. (Gmelin Inst.)

**29653** ION-SOURCE FOR A SYNCHRO-CYCLOTRON. G. M. Baptist van Nimwegen (to N. V. Philips' Gloeilampenfabrieken). German Patent 1,149,468. May 30, 1963. Priority date Sept. 14, 1960, Netherlands.

A Penning-type ion source for a synchrocyclotron is described, which is provided with a socket as anode and a tungsten rod as cathode. The socket is provided with a bore parallel to the magnetic lines of force of the cyclotron through which ions, electrons, and neutral molecules pour out into the accelerating gap of the D-shaped electrodes. The ion output of such an ion source can be substantially increased (30 to 40%) when the bore of the socket is surrounded by a large number of channels located on the surface of a cone the axis of rotation of which coincides with the bore, the peak of this cone being situated within the accelerating gap. Through the channels a fourth to a third of the entirely consumed amount of gas is fed in. (Gmelin Inst.)

## Plasma Physics and Thermonuclear Processes

**29654** (LADC-5530) PLASMA COMPRESSION EXPERIMENTS. I. EFFECTS OF A HEXAPOLE MAGNETIC FIELD ON STABILITY. E. M. Little and W. E. Quinn (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract [W-7405-eng-36]. 18p.

A hexapole magnetic field was superimposed on the fast magnetic mirror compression field of the Scylla III $\theta$-pinch in an attempt to stabilize an observed plasma instability of the flute type with a superimposed rotation. The effect of the hexapole field on the plasma stability was studied with streak camera photography and through observation of the neutron emissions. Under certain condi-

tions the hexapole "stabilizing" field has an observable effect on the instability. Its main effect is to symmetrize the rotation about the axis of the compression coil and to produce a delay in the onset of the instability. There is at most a small effect tending to symmetrize the time distribution of neutron emission and to increase the neutron yield. (auth)

**29655** (LADC-5531) PLASMA COMPRESSION EXPERIMENTS. II. EFFECTS OF PREIONIZATION AND BIAS FIELDS ON STABILITY AND HEATING. E. M. Little and W. E. Quinn (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract [W-7405-eng-36]. 18p.

A highly ionized deuterium plasma is produced by a fast, low energy capacitor bank coupled directly to the single-turn compression coil of the Scylla III device. The after glow of this preionization discharge, uniformly permeated by a magnetic bias field $B_0$, forms the initial condition for the application of the main magnetic compression field. The effect of the main compression field on the preionized plasma depends strongly on the $B_0$ that exists in the plasma. Generally, the present results confirm the previous observations made with either an axial-discharge or an rf preionizer: with $-B_0$, a hot plasma having the usual properties of a second-half-cycle plasma is produced on the first magnetic half cycle; neutron emission occurs only for negative $B_0$; and little x-ray emission and no neutron emission occurs for positive $B_0$. However, some additional effects are observed: appreciably higher electron temperatures occur for $-B_0$ than those previously observed; $T_e$ is independent of $-B_0$ providing its magnitude exceeds a few kG; a hollow core of trapped $-B_0$ persists throughout most of the compression half cycle for intermediate $B_0$ values; neutron and soft x-ray emissions occur during the compression phase over a relatively wide range of time intervals between the initiation of the preionizer and main compression circuits; and for intermediate values of $-B_0$, a rotating flute instability develops. It is similar to that observed during the second half cycle with weak preionization. (auth)

**29656** (LAMS-2916) QUARTERLY STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR PERIOD ENDING MAY 20, 1963. (Los Alamos Scientific Lab., N. Mex.). June 25, 1963. Contract W-7405-eng-36. 55p.

Electron beam probe experiments were performed on Picket Fence IIB to study the characteristics of the potential well formed after plasma injection into the cusped field and to search for time-dependent electric fields developed by instabilities in the low-$\beta$, long-time duration plasma. The energies, masses, and time behavior of ions escaping through the ring cusp were also studied. Measurements of particle leakage through the point cusp of the Picket Fence III machine with plasma injection from the new large-bore coaxial gun showed no tail in the D-flux leakage. Analog computer amplifiers were used to improve the sensitivity of measurements and to speed data analysis in plasma diagnostics. Investigation of the high-pressure mode operation of a coaxial gun were made, and center electrodes of various shapes and sizes were tested in the large-bore gun. Development of equipment, procedures, and theory for detecting plasma oscillations by the incoherent scattering of microwaves from such oscillations were resumed. A double-light-beam experiment was devised. A 10-$\mu$F capacitor with an internal inductance of less than $10^{-10}$ H was built. Scylla IV was brought into operation. With the preionizer, first-half-cycle electron temperatures of 300 to 900 ev and neutron yields of $10^7$ to $10^9$ were observed. The plasma was found to be capable of casting a distinct image of itself due to refractive effects. At peak compression, shadowgrams indicated a plasma with a sharp, nearly circular boundary. Evidence of a Faraday rotation was also noted. Mirror machine injection with a coaxial plasma gun was studied using five mirror machine arrangements. Evidence for trapping was found, but little was known of the trapping mechanism or the plasma properties. Experiments continued with the original transverse injection apparatus, and construction of a new device approached completion. The experiments indicated that a sustained E-field gate is useful for stopping the plasma that arrives more than 7-$\mu$sec behind the front of the slow-moving component. Component developments are also reported. (D.C.W.)

**29657** (ML-1038) A STUDY OF SYSTEMS FOR SPACE PROPULSION. Quarterly Progress Report No. 9, February 1–April 30, 1963. (Stanford Univ., Calif. Microwave Lab.). May 1963. Contract NAS-8-1509. 34p.

Analytical and experimental evaluations of possible space-charge flow configurations suitable for use in ion guns, having as an ultimate objective the establishment of design criteria for high-current-density ion diodes of minimum ion interception characteristics, are made. (N.W.R.)

**29658** (RM-3364-PR) THE MOTION OF ELECTRONS IN A RADIOFREQUENCY FIELD. Mary F. Romig (RAND Corp., Santa Monica, Calif.). June 1963. Contract AF49 (638)-700. 49p.

The motion of electrons in a radiofrequency field is investigated for a cylindrical geometry and an electromagnetic-field configuration consisting of a spatially constant axial magnetic field and an azimuthal electric field that varies linearly with distance from the center of the cylinder. This field configuration, which approximates that found in the electrodeless ring discharge near breakdown, has also been suggested as a plasma-confinement scheme. When the motion is collisionless, the equations can be solved analytically to show that stable (time-bounded) motion exists for certain values of the ratio of electron cyclotron frequency to applied field frequency. Confinement of the orbits to a region entirely inside the cylinder is completely assured only for those particles which start from rest; in all other cases the maximum radius of extent depends on initial position and velocity. Collisions are qualitatively accounted for in a crude manner by use of the Langevin equation, which includes a drag force due to collisions in the equations of motion. Even with this simple model the resulting equation is apparently intractable except by machine solution. It is therefore not possible, without analytic solutions, to discuss the effect of collisions of this type on the stability of the motion, although it appears from several of the examples that an initially unstable or divergent motion quickly damps out when the friction force is added, and that for large friction forces, the mean motion is always stable. Confinement is not ensured, however, because diffusion is not included in the basic equations. Some numerical examples of the motion are presented for both the collisionless case and the Langevin equation. An approximate solution is obtained for the case with collisions that adequately describes the mean motion whenever the ratio of collision frequency to field frequency is larger than three. (auth)

**29659** (SSD-TDR-63-72) MAGNETIC INSULATION EXPERIMENTS WITH A TRAVELING MAGNETIC PISTON PLASMA ACCELERATOR. Glenn C. Light (Aerospace Corp., El Segundo, Calif.). May 8, 1963. Contract AF04 (695)-169. 44p. (AD-407339; TDR-169(3210-05)TN-2)

Experimental work on a traveling magnetic piston plasma accelerator is reported. This accelerator produces a shock wave traveling at $1.1 \times 10^7$ cm/sec. Ideally, that is, if there were no plasma losses and if the piston has a flat face normal to its motion, the accelerator would produce a 12-cm long uniform plasma slug filling the shock tube cross section. Actually, the magnetic piston face is not flat. Since the effective length of the piston is of the same order as the ideal length of uniform plasma, the plasma will expand to fill the tube cross section when the piston stops; this will produce a non-uniform slug even if there is no loss of plasma. In an attempt to inhibit the flow to the boundary layer, a uniform axial magnetic field was put on the shock tube. This applied magnetic field also alters the piston shape as well as the plasma leakage through the piston. It is difficult to determine from preliminary experiments which effect is responsible for the observed changes in the flow; nevertheless, the experimental data are interesting. These data indicate that for certain orientations and strengths of axial magnetic field, the attenuation of shock wave velocity beyond the exit of the accelerator is markedly reduced. Experimental data taken with streak camera and Kerr Cell are shown. (auth)

**29660** (UCRL-7083) DEVELOPMENTS IN AEC SHERWOOD PROGRAM FOR CONTROLLED NUCLEAR FUSION POWER. Hyman Olken (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 5, 1962. Contract W-7405-eng-48. 6p.

A full-scale machine built for studies of the Astron concept for a fusion reactor comprises an electron gun yielding a 200-amp electron stream, an induction accelerator to accelerate the electrons to 5 Mev, and a tank in which the electron layer forms. Energy storage banks, switches, pulse transformers, and modulators developed for the machine are also mentioned. (D.C.W.)

**29661** (UCRL-10800) ON THE HEATING OF ELECTRONS IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Wulf B. Kunkel and Gary A. Pearson (California. Univ., Berkeley. Lawrence Radiation Lab.). June 19, 1963. Contract W-7405-eng-48. 15p.

The velocity distribution of electrons in a very weakly ionized gas under many conditions tends to be nearly isotropic even in the presence of electric and magnetic fields. It is shown that in such cases the rate of electron heating can be represented as a spherically symmetric diffusion in velocity space without the usual restriction to steady-state conditions. In the case of a steady electric field perpendicular to a strong magnetic field, the pertinent velocity-diffusion coefficient has the simple form $D = v_d^2 \nu/3$, where $v_d = cE/B$ is the drift speed and $\nu$ is the momentum-transfer collision frequency. (auth)

**29662** (NP-tr-1034) EXPERIMENTS ON HELICAL INSTABILITY IN THE POSITIVE COLUMN IN A MAGNETIC FIELD. Susumu Shimamoto, Shingo Imazu, and Yoshiei Nakano. Translated by L. Allen (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks., Eng.) from Kakuyugo-Kenkyu, 9: 463-72(Nov. 1962). 19p.

The positive column of a d-c discharge in a magnetic field becomes unstable for a longitudinal magnetic field exceeding a critical value $B_c$. Measurements were made, with emphasis on the growth and properties of the instability, to permit a quantitative comparison with the theory of Kadomtsec and Nedoxpasor. The oscillating floating potentials were observed with Langmuir probes, the tips of which were spaced at the tube wall. The properties of the helical state were measured in He gas as functions of magnetic field and discharge current. The frequency and the wave length are in fairly good agreement with the theoretical predictions of Kadomtsec and Nedoxpasor. (auth)

**29663** GENERALIZED THEORY OF THE THERMIONIC PLASMA ENERGY CONVERTER. M. E. Talaat (Martin Co., Baltimore). Appl. Ind., No. 63, 309-20(Nov. 1962).

Basic principles of thermionic emission, ion generation, and plasma properties are used to examine a model of the vapor-filled thermionic plasma energy converter. The model divides the converter's interelectrode space into plasma, emitter, and collector sheath regions. At least seven main equations evolve from consideration of these three regions, namely, current, charge, plasma ion, plasma energy, and voltage balance equations. Repeated solutions of these equations at various load currents yield the current-voltage characteristic curve. A generalized efficiency expression is also presented. (auth)

**29664** STATUS AND OUTLOOK OF PLASMA PHYSICS RESEARCH. W. Heisenberg (Max-Planck-Institut für Physik und Astrophysik, Munich). Atomwirtschaft, 8: 290-1(May 1963). (In German)

The interest in plasma physics springs from the hope of obtaining energy by technically controlled fusion in a hot plasma. Extensive research showed however that there were considerable difficulties standing in the way. Plasma physics research was turned therefore to numerous individual problems which it would be necessary to solve before these difficulties could possibly be overcome. The work includes experiments with varied geometrical configurations for the containment of the plasma, investigations of the properties of the plasmas so produced and, in particular, of the instabilities which occur. With the wide-ranging development of plasma physics application possibilities other than fusion have arisen such as, e.g. the conversion of chemical and thermal energy into electrical energy, plasma propulsion for rockets, etc. (auth)

**29665** INTERNATIONAL RESEARCH INTO THE PROBLEMS OF FUSION. L. Biermann (Institut fur Plasmaphysik und Max-Planck-Institut für Physik und Astrophysik, Munich). Atomwirtschaft, 8: 291-3(May 1963). (In German)

The research on fusion which is being intensively pursued in many countries is discussed. The main problem of controlled fusion is to hold a gas of a heavy isotope of hydrogen at a temperature of at least a 100 million degrees for a long enough time, i.e. for a not too small fraction of a second. Euratom countries are not included in the review. Particular mention is given to: the torus arrangements in Great Britain, the U.S.A., Russia, and Sweden; the experiments on the fundamentals of the stellarator principle in the U.S.A. and Japan; the investigations with mirror machines in the U.S.A. and Russia; and the experiments with magnetic compression in the U.S.A. and Great Britain. In the field of theory the conditions for the stability of a plasma are one of the most important themes. (auth)

**29666** PLASMA PHYSICS RESEARCH IN THE GERMAN FEDERAL REPUBLIC. H. Bartels (Technische Hochschule, Hanover). Atomwirtschaft, 8: 294-7(May 1963). (In German)

Systematic research into plasma physics is being carried out in Germany in six institutes of varying sizes. In the Institute for Plasma Physics in the Jülich Nuclear Research Establishment work is essentially concentrated on fast magnetic compression and the development of a plasma accelerator. In the Physics Institute of Kiel Uni-

versity the original emphasis was on the spectroscopic investigation of plasmas in thermal equilibrium. Later the stationary arc column itself was the object of much work into the arc plasma. Shock wave problems and the effect of time varying conditions on the transition to plasma are the subjects of particular investigations. The Institute for High-Temperature Research at the Stuttgart Technische Hochschule is limiting its work to dense plasmas for which a special arc construction was developed. Special investigations are concerned with the plasma rays which emerge from the electrodes of the arc column. These investigations are supplemented by work on the theory of plasma streaming. The research laboratory of the Siemens-Schuckertwerke in Erlangen was concerned for 10 years with problems of plasma physics, at first on the arc column and later on a pulsed current installation for investigating the linear Z-pinch. A new kind of plasma gun was developed. Plasmas of high and very high densities are being investigated in the Institute for Plasma Physics at the Hanover Technische Hochschule, mainly by spectroscopic methods whose possibilities were essentially expanded. (auth)

**29667** THE EURATOM PROGRAM OF FUSION RESEARCH. D. Palumbo (Euratom-Kommission, Brussels). Atomwirtschaft, 8: 297-300(May 1963). (In German)

Since 1959 the Euratom Commission has concluded association contracts for research work in the field of plasma physics with five authorities: CEA (France), CNEN (Italy), FOM (Holland), as well as with the Institute for Plasma Physics and the Jülich Nuclear Research Establishment (Germany). Work with magnetic bottles is in progress at Saclay and Fontenay-aux-Roses in France as well as in Amsterdam and Jutphaas, Holland. Linear-Z-pinch experiments will be undertaken in Arnhem, Holland. Toroidal equilibrium states are being investigated theoretically and experimentally at Fontenay-aux-Roses. The commonest arrangement in Europe is the Theta-pinch: CARIDDI at Frascati, Italy, Hard-Core-Pinch MEST at Fontenay-aux-Roses, and a magnetic field rotating in a toroidal discharge on the plasma surface at Jutphaas. In addition, by means of the MIRAPI and MAFIN experiments, an attempt is being made in France to achieve an extremely dense and hot plasma which is however only partially enclosed. (auth)

**29668** THE INSTITUTE FOR PLASMA PHYSICS IN GARCHING, ORIGIN, DEVELOPMENT, AND ORGANIZATION. E. Telschow and G. Lehr. Atomwirtschaft, 8: 302-4(May 1963).

The history of the Institute, its operating costs and financing, the personnel, the building arrangements, and the work of the Institute are discussed. Research on the Theta Pinch, the production and behavior of plasmas under special conditions, the production of stationary plasmas in the temperature region of 100000°K, and equipment for use in plasma physics is in progress. Quasi-hydrodynamic and microscopic models are being used in theoretical studies. (M.C.G.)

**29669** POWER SUPPLIES OF THE INSTITUTE FOR PLASMA PHYSICS. K. H. Penkalla (Siemens-Schuckertwerke AG, Munich); K. H. Schmitter, and H. Vierfuss. Atomwirtschaft, 8: 321-3(May 1963). (In German)

The experimental scope of a plasma physics institute is essentially determined by the electrical supply arrangements. The consumer categories of the Garching Institute can be divided into the following groups: fixed installation equipment with load demands of up to 500 kva: movable equipment with ratings up to 40 kva but without any special requirements on voltage constancy, equipment similar to the last category but requiring protection against mains variations; equipment which requires a stabilised mains voltage; equipment with short time high power demands (over 1 Mva) as well as equipment with special requirements in respect of frequency or of voltage. The planning and construction of the power supply system are described. (auth)

**29670** THE ENERGY SUPPLY FOR THE LARGE THETA-PINCH EXPERIMENT AT GARCHING. A. Knobloch (Institut für Plasmaphysik GmbH, Garching, Ger.). Atomwirtschaft, 8: 323-4(May 1963). (In German)

An account is given of the basic arrangement, construction and data of the 1.5 Mw energy store for a large Theta pinch experiment in the Garching Institute for Plasma Physics. The installation comprises three condenser batteries: one 10 kv battery, a fast 40 kv battery, and the main battery with a charging voltage of 30 or 40 kv corresponding to an energy content of 1.5 or 2.7 Mw respectively. The maximum compression field of the discharge coil amounts to 90 to 180 kG. It is expected that the density of plasma produced will be about $10^{17}$ to $10^{18}$ $cm^{-3}$, the temperature some $10^{7}$°K. The parts of the energy store which are most highly stressed and significant are proportioned to have a life of $10^{5}$ discharges at 30 kv and about $2.10^{4}$ discharges at 40 kv charging voltage. (auth)

**29671** FUNDAMENTALS AND PROBLEMS OF PLASMA PHYSICS. E. Geissler (Institut für Plasmaphysik der KFA, Julich, Ger.). Atomwirtschaft, 8: 325-8(May 1963). (In German)

The way in which gases can be converted into plasmas by the supply of thermal energy is described. In addition to the production of plasmas, their heating, containment, and cooling are significant and the most important processes are illustrated. The reaction conditions are also of importance, particularly in respect of the technical utilization of the fusion energy. The investigation of high temperature plasmas is significant for the direct conversion of thermal into electrical energy. In addition to the production of electrical energy there are application possibilities to space travel. (auth)

**29672** DEVELOPMENT IN SPHERICAL HARMONICS OF THE COLLISION TERM OF THE FOKKER-PLANCK EQUATION. Pierre Bertrand, Raymond Jancel, and Théo Kahan. Compt. Rend., 256: 4628-30(May 27, 1963). (In French)

Distribution functions of the charged particles of an ionized gas are approximately determined by limited development in spherical harmonics in the velocity space. It is shown how this method can be applied to the case of strongly ionized gas because of the systematic study of a bilinear operator of the collision term of the Fokker-Planck equation. (tr-auth)

**29673** LAMINAR, PLANE FREE JET OF AN INCOMPRESSIBLE FLUID IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. René Moreau (Université, Grenoble, France). Compt. Rend., 256: 4849-52(June 5, 1963). (In French)

Some results occasioned by the affine solution established previously (Compt. rend., 256: 2294(1963)) are analyzed, and the basic hypothesis of the boundary layer is discussed. (tr-auth)

**29674** TEST INSTALLATION OF THE FLUID MECHANICS LABORATORIES OF THE UNIVERSITY OF GRE-

NOBLE. René Moreau (Université, Grenoble, France). Compt. Rend., 256: 5052-4(June 10, 1963). (In French)

A description is given of a mercury loop designed for the study of various types of laminar and turbulent discharge in the presence of a uniform transverse magnetic field. (tr-auth)

**29675** EXPERIMENTAL STUDY OF PLACING AN ELECTROCONDUCTING LIQUID IN LAMINAR OR TURBULENT MOTION IN A CIRCULAR CROSS SECTION TUBE IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Étienne Crausse, René Causse, and Yves Poirier (Faculté des Sciences, Algiers). Compt. Rend., 256: 5055-7 (June 10, 1963). (In French)

An experimental study was made of placing a viscous and electroconducting liquid in motion in a tube with uniform circular section in the presence of a uniform magnetic field normal to the tube axis. The pressure difference between the basin level and the tube axis and the Hartmann number was varied. Three transitory regimes of different natures were distinguished: laminar regime, turbulent regime, and intermediary regime. Experimental curves for the three regimes are given. (J.S.R.)

**29676** STATIONARY CYCLOTRON WAVES IN THE COLLISION OF TWO BEAMS OF ELECTRONS. Claude Étiévant and Mario Perulli. Compt. Rend., 256: 5080-2 (June 10, 1963). (In French)

The instability mechanism in the vicinity of the cyclotron semifrequency intervening in the collision of two electron beams in a magnetic field was studied in a symmetrical apparatus allowing the formation of stationary waves. The wave lengths were measured. They confirm that the excited waves are slow waves whose phase velocity is of the order of the velocity of beams. (tr-auth)

**29677** RADIATION CLOSE TO THE CYCLOTRON RESONANCE FROM A CHARGE MOVING IN A PLASMA. A. E. Bazhanova and V. D. Shafrqnov. Dokl. Akad. Nauk SSSR, 149: 1049-51(Apr. 11, 1963). (In Russian)

A charge, circulating in a magnetic field B with a velocity $v_\perp \ll c$, radiates in vacuum at the cyclotron frequency $\omega_B = eB/mc$, but in a plasma, a shift from the cyclotron frequency can occur. This radiation should depend on the refractive index N, and as a consequence, on the plasma density $n_0$. In order to determine whether or not this radiation can be used to measure the density of a plasma, calculations were carried out on a computer to obtain the intensity of radiation from an electron or ion near its cyclotron frequency. The refractive index of a "cold" plasma was used in the calculations, since it is assumed that the plasma is transparent to the radiation. The calculations showed that most of the radiation is concentrated in a narrow region of frequencies close to an optimum frequency $\omega = \omega_{opt}$. The optimum frequency $\omega_{opt}$ depends strongly on the density of the plasma. The ratio of the intensity of radiation from an electron in a plasma to that in vacuum $f_e = I/I_0$, and the relative optimum frequency of the radiation $x_{opt} = \omega_{opt}/\omega_B$ are given as functions of $\beta_2 = v_{||}/c$, and $A^2 = \omega_0^2/\omega_B^2$. An analogous calculation was carried out for ions, since radiation from ions is of interest in analyzing cosmic radio emission. (TTT)

**29678** HYDRODYNAMIC OSCILLATIONS OF A NON-UNIFORM, LOW-PRESSURE PLASMA IN A MAGNETIC FIELD. L. M. Kovrizhnykh, E. E. Lovetskii, A. A. Rukhadze, and V. P. Silin (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 149: 1052-5(Apr. 11, 1963). (In Russian)

Second order differential equations of the type $\lambda^2 y'' + q(\omega,x)\, y = 0$ must be solved in considering the stability of a non-uniform plasma. Here, $\lambda$ is small compared to the value of the function $q(\omega,x)$. Symptotic solutions of the second-order differential equations can be used to find criteria for instability of a plasma. This method, adopted from the field of geometrical optics, was applied to the problem of longitudinal oscillations of a cold plasma in a gravitational field. The instabilities of the plasma were analyzed in a general way. The method was also applied in analyzing the oscillations of a non-uniform plasma contained by a strong magnetic field for the case where the magnetic pressure is significantly greater than the kinetic pressure. A dispersion equation was derived for determining the spectrum of oscillations in a non-uniform plasma. The stability limits of the plasma were analyzed. (TTT)

**29679** THE FORCE LINES OF THE MAGNETIC FIELD FROM THE VORTEX CURRENTS FLOWING OVER THE SURFACE OF A TORUS. V. K. Mel'nikov (United Inst. of Nuclear Studies). Dokl. Akad. Nauk SSSR, 149: 1056-9 (Apr. 11, 1963). (In Russian)

The behavior of the force lines of the magnetic field resulting from the vortex currents flowing along the surface of a torus is important in stellarator theory. The results of this study show that the nonsymmetry of this type of magnetic field is one of the reasons for the production of protuberances on the surface of the plasma. This effect of the nonsymmetry of a helical magnetic field can be controlled to a significant extent by means of an additional vertically orientated magnetic field of a definite strength. The distribution of force lines of the magnetic field from the helical currents flowing over the surface of a torus can be approximated by studying the distribution of force lines of the magnetic field from the helical currents flowing along the surface of a cylinder, on which a particular perturbation was imposed in a special fashion. Expressions for the components of the magnetic field are presented. (TTT)

**29680** INSTABILITIES OF TRANSVERSE WAVES IN A DRIFTED PLASMA. J. Bok and P. Nozieres (Ecole Normale Superieure, Paris). J. Phys. Chem. Solids, 24: 709-14(June 1963). (In English)

A study is made of the propagation of transverse electromagnetic waves in a drifted plasma, in the presence of a longitudinal d-c magnetic field. The complex conductivity of such a plasma containing two kinds of particles of opposite charge (for instance electrons and holes in a semiconductor) is first derived. From the dispersion relations, the conditions for instability or amplification of the wave are then deduced. The threshold drifting electric field $E_{D0}$ is derived as a function of the longitudinal magnetic field $B_0$ and the frequency of the wave. This formula is applied to a practical case, namely InSb at 77°K and 300°K. (auth)

**29681** ELECTRON DISTRIBUTION IN LOW-VOLTAGE ARCS. R. C. G. Leckey, G. S. Higginson, and K. G. Emeleus (Queen's Univ., Belfast). Nature, 198: 1187-8 (June 1963).

Measurements of the fast electron group in a low-voltage arc in a device without a control electrode are reported. The distribution perpendicular to the axis follows a bell-shaped curve and can be accounted for by diffusion theory. The locus of maxima parallel to the axis indicates a possible contribution to the winging sometimes seen to start at a cathode edge. (D.L.C.)

**29682** A NEW GRAPH-ANALYTICAL METHOD FOR DETERMINING THE CHARACTERISTICS OF AN ELEC-

TRIC ARC WITH ISOTHERMAL PLASMA IN CASE OF ALTERNATING CURRENT. I. K. Fedchenko and O. S. Ilenko (Kiev Polytechnical Inst.). Dopovidi Akad. Nauk Ukr. RSR, No. 4, 472-4(1963). (In Ukrainian)

A new method is developed to determine under different conditions and various parameters of the external circuit the law of changes of the main parameters (current and voltage) of an electric arc with time qualitatively and quantitatively. (auth)

**29683** THE STATE OF RESEARCH ON CONTROLLED THERMONUCLEAR REACTIONS. L. A. Arcimovic. Fortschr. Physik, 10: 681-90(1962). (In German)

Progress in research on controlled thermonuclear reactions is reviewed. Apparatuses and techniques are described. (M.C.G.)

**29684** DOUBLE PROBE MEASUREMENTS OF ELECTRON TEMPERATURES IN A SHOCK TUBE. T. I. McLaren, J. N. Fox, and R. M. Hobson (Clarke, Chapman and Co., Ltd., Victoria Works, Gateshead, Eng.). Nature, 198: 1264-5(June 29, 1963).

The measurement of electron temperatures and concentration in shock-generated plasmas by Langmuir probes generally is not reproducible. A double probe is designed with a hairpin geometry for easier cleaning by means of an electric current passed through the probe between shocks. Measurements are very reproducible for this probe, and some measurements are compared with expected values. (D.L.C.)

**29685** A SPECTROSCOPIC METHOD OF MEASURING ELECTRON TEMPERATURES IN PLASMAS. L. Heroux (United Kingdom Atomic Energy Authority, Abingdon, Berks, Eng.). Nature, 198: 1291-3(June 29, 1963).

A new spectroscopic method for high-temperature plasmas is presented which is based on the relative intensities of spectral lines from the same species of Li-like ion. The case is considered in which the only excitation processes are excitation from the ground state by electron collision, followed by photon emission. An intensity ratio was developed for the transitions $2s^2S_{1/2} - 2p^2P^0_{3/2}$ (q) and $2s^2S_{1/2} - 3p^2P^0_{3/2}$, $s_1$ (r): $I_{1q}/I_{1r} = [f_{1q}\chi_{1r}g(\chi_{1q}/kT_e)/f_{1r}\chi_{1q}g(\chi_{1r}/kT_e)] \exp(\chi_{1r} - \chi_{1q}/kT_e)$, where f and $\chi$ are the absorption oscillator strength and excitation potential of the transitions. Criteria for the validity of the equation are given; in order to meet them, the collisional depopulation must be unimportant, and the plasma must be optically thin. Although the equation was developed for a steady-state condition, it is still valid for transient plasma conditions since the relaxation time is very short. The method was applied to the pinch discharge Zeta. Calibration results and some electron temperature measurements for $D_2 + N_2$ are given. (D.L.C.)

**29686** A NEW COIL FOR THE $\theta$ PINCH. Hans Bartels and Dieter Meiners (Technische Hochschule, Hanover). Naturwissenschaften, 50: 396-7(1963). (In German)

A coil for the theta pinch was developed, which consists of two copper cylinders, one within the other, with countercurrently slanting slots. They are joined together at one end by a massive copper ring, while at the other end they are isolated from each other by a circular projecting disk. (M.C.G.)

**29687** A NOTE ON PLASMA OSCILLATIONS IN A MAGNETIC FIELD. A. K. Rajagopal (Harvard Univ., Cambridge, Mass.). Phys. Letters, 5: 40-2(June 1, 1963). (In English)

A concise derivation of the dispersion relation satisfied by longitudinal plasma oscillations of an electron gas in an external magnetic field at finite temperatures by a Green function method is given. The result derived is simpler and has a different structure than those obtained by Stephen and Zyryanov. The method used is a variant of that used by Nambu in his superconductivity theory as well as by Rajagopol and Ranganathan in their study of spin waves in a ferromagnetic electron gas. (auth)

**29688** THE SCATTERING OF ELECTRONS BY A MAGNETIC FIELD CONTAINING IN AN IMPENETRABLE TORUS. L. J. Tassie (Australian National Univ., Canberra). Phys. Letters, 5: 43-4(June 1, 1963). (In English)

By using the method Peskhin followed in considering electron scattering by magnetic fields inside impenetrable cylinders, it is shown that electron scattering by an impenetrable torus containing a magnetic flux $\pi\hbar c/e$ is the same as the scattering by a disc surrounded by a torus. Cross sections are obtained. (D.C.W.)

**29689** MEASUREMENTS OF ELECTRON-ION RECOMBINATION IN A THERMAL CESIUM PLASMA. J. Y. Wada and R. C. Knechtli (Hughes Research Labs., Malibu, Calif.). Phys. Rev. Letters, 10: 513-16(June 15, 1963).

Recombination was investigated by a previously described technique using a thermal Cs plasma generated by contact ionization of Cs vapor and thermionic emission of electrons. The values obtained agree with values predicted by the theory of collisional-radiative recombination. The conclusion is that recombination by electron-electron-ion collisions predominates for ionizations of 7 to 90% and plasma densities of $10^{12}$ to $10^{14}$ $cm^{-3}$, while dissociative recombination is of no importance. The rates of collisional-radiative recombination for $Cs^+$ and $H^+$ plasmas appear to be similar as predicted. (D.C.W.)

**29690** ON ELECTROSTATIC PLASMA CONFINEMENT. [PART] I. O. A. Lavrentev (Inst. of Physics and Tech., Khar'kov). Ukr. Fiz. Zh., 8: 440-5(1963). (In Ukrainian)

The plane and spherical Langmuir problem for a bipolar current with arbitrary distribution of particles by velocities is considered. Conditions are found for the existence of a potential well in a drift space. A dependence is found between the density of the ions confined in the potential well and the magnitude of the electron beam reflected by the external fields. (auth)

**29691** ON THE REFLECTION OF PLASMA BY A MAGNETIC FIELD LAYER. [PART] II. O. A. Lavrentev (Inst. of Physics and Tech., Khar'kov). Ukr. Fiz. Zh., 8: 446-51(1963). (In Ukrainian)

The magnitude of the magnetic field and width of the magnetic slit, at which the conditions of high-temperature plasma confinement by a system of external electric and magnetic fields are satisfied are determined. (auth)

**29692** ENERGY AND DENSITY OF IONS IN AN ELECTROMAGNETIC TRAP. [PART] IV. O. A. Lavrentev, L. I. Ovcharenko, B. G. Safronov, V. O. Sidorkin, and B. A. Nemashkalo (Inst. of Physics and Tech., Khar'kov). Ukr. Fiz. Zh., 8: 452-9(1963). (In Ukrainian)

The conditions for low-density plasma confinement in an electromagnetic trap were studied. The electron density in the trap at the moment of formation of the space charge was determined by the injection current of the electrons, while the density of the electrons after the termination of electron injection was determined by the emissivity on opening the axial electrostatic plug. The lifetime of the electron was determined. The mean energy of the ions emerging from the trap was measured by the retarding po-

tential method. The actual energy of the ions is the sum of this mean energy and the potential well energy that was determined by the time of flight of krypton ions through the internal region of the trap. (auth)

**29693** MAGNETIC SOUND IN A PLASMA WITH THERMAL MOTION. II. ABSORPTION OF MAGNETOSOUND WAVES IN A PLASMA. V. P. Demidov, D. A. Frank-Kamenetskii, and V. L. Yakimenko. Zh. Tekhn. Fiz., 33: 398-405(Apr. 1963). (In Russian)

The process of absorption of magnetic sound waves in a fully ionized plasma with thermal motion was examined. These waves are radially distributed with respect to a constant magnetic field and have frequencies which are higher than the cyclotron ion frequency but much less than the cyclotron electron frequency. The absorption was calculated for the various harmonics in the cyclotron ion frequency. In addition, the electron Cherenkov absorption was determined. Finally, the absorption arising from collisions between the ions and the electrons was considered. (TTT)

**29694** CONCERNING THE FIELD STRUCTURE IN A TRANSVERSE CROSS SECTION OF A WAVEGUIDE FILLED WITH PLASMA. V. P. Demidov. Zh. Tekhn. Fiz., 33: 406-11(Apr. 1963). (In Russian)

The field structure was examined for waves being propagated in a waveguide containing a plasma. The waveguide is considered to have ideally conducting walls. It is filled with a plasma, the thermal motion of whose particles is ignored. Inside the waveguide there exists a constant homogeneous magnetic field directed along the waveguide axis. The plasma is assumed to be sufficiently dense so that the longitudinal electric field can be ignored with respect to the transverse electric field. Formulas were obtained and diagrams are shown. These formulas and diagrams describe the magnetic fields for waves whose azimuthal number, m, can be equal to zero or to plus or minus one. (TTT)

**29695** INSTABILITY IN A SINGLE WAVE TRAVELING IN A PLASMA ALONG A MAGNETIC FIELD. A. D. Pataraya. Zh. Tekhn. Fiz., 33: 412-14(Apr. 1963). (In Russian)

The instability of a single wave, traveling in a two-component quasi-neutral plasma, was examined. The special case investigated was for the wave moving along a magnetic field. The problem was considered in the particular coordinate system in which the wave moved with a constant velocity. It was assumed that the physical quantities present in a turbulence are not very different from the same quantities valid for a quiescent period. Further, it was proposed that the frequency of the disturbing oscillations is much greater than the Larmor frequency of the electron. A differential equation was derived which describes the perturbation in the electron density. The behavior of the kinetic energies of ions inside the single wave was investigated with respect to changes in the potential energy of the electric field. (TTT)

**29696** AUTOMODEL MOTIONS OF A CYLINDRICAL PLASMA COLUMN. B. N. Krasnov. Zh. Tekhn. Fiz., 33: 415-18(Apr. 1963). (In Russian)

The problem of electromagnetic containment of an infinitely extended cylindrical plasma column was examined. The plasma column is situated in a magnetic field which varies with time; the magnetic lines of force are rectilinear and parallel to the axis of the column. The plasma is assumed to be completely ionized, singly charged, and neutral. Under these conditions automodel solutions were obtained for the equations describing an isothermal plasma contained by a varying quasistationary electromagnetic field. The solutions are determined when the magnetic field and the plasma temperature vary exponentially with time and also when these two quantities have a step dependence on the time. (TTT)

**29697** RADIOPROBING OF CLOTS IN PLASMAS. V. B. Brodskii, B. M. Belitskii, S. E. Zagik, V. A. Lyutomskii, and A. V. Spiridonov. Zh. Tekhn. Fiz., 33: 419-25 (Apr. 1963). (In Russian)

A method is described for the radioprobing of clots present in plasmas. The method is based on the simultaneous irradiation of the clots by several well-focused beams of radio waves. Results are presented on the investigation of plasma clots obtained in a coaxial impulse accelerator. The radio-optical apparatus consists of two elliptical mirrors with a common focus on the axis of the flight path of the clots. The mirror focus can be changed sufficiently so that in the neighborhood of the clots the radio waves can be assumed to be parallel. Radio waves 3 cm and 8 mm in wavelength were utilized, and the signals were displayed on an oscillograph. In some of the displays a small clot was observed moving in front of the main clot. Velocities were measured for the plasma fronts. The measurements were also made for different capacities of the accelerator condenser batteries. (TTT)

**29698** RADIOPROBING OF A PLASMA MOVING IN A DIRECTION OPPOSITE TO THE ELECTRODYNAMIC ACCELERATION IN A COAXIAL ACCELERATOR. V. B. Brodskii, B. M. Belitskii, A. T. Voronchev, N. V. Konyakhin, and Yu. N. Starostin. Zh. Tekhn. Fiz., 33: 426-8 (Apr. 1963). (In Russian)

The ratio of the number of charged particles moving in a direction opposite to the electrodynamic acceleration in a pulsed coaxial accelerator to the number of charged particles moving in the direction of acceleration was determined. Two radio wave signals were used simultaneously for probing. The two wavelengths were 0.8 and 3.0 cm. The recorded signals were displayed on an oscillograph. In the acceleration direction a concentration of greater than $10^{13}$ electrons/cm$^3$ was measured; the time of traversal was found to be 80 microseconds and the velocity of the plasma clots was measured to be $10^7$ cm/sec. In the opposite direction, the concentration was $10^{12}$ electrons/cm$^3$, the traversal time was 40 microseconds, and the velocity was $4 \times 10^6$ cm/sec. From these measurements it was determined that the number of particles moving in the opposite direction was less than or equal to 2% of the number moving with the direction of acceleration. (TTT)

**29699** PASSAGE OF A SIGNAL BETWEEN TWO SUPERHIGH FREQUENCY PROBES IN A PLASMA. S. M. Levitskii and I. P. Shashurin. Zh. Tekhn. Fiz., 33: 429-36 (Apr. 1963). (In Russian)

A critical analysis was made of the method for measuring the electron concentration in a plasma by the use of two super-high-frequency probes. It is shown that the passage of the signal corresponds to a minimum, not a maximum, in the plasma resonance. Observed maxima can be explained by the presence of volume discharge layers present on the probe surfaces. Alternately, the maxima may arise from the excitation of plasma waves. Therefore, these maxima cannot, unambiguously, be used with the view of diagnosing plasmas. An experiment is described in which the excitation of plasma waves in the neighborhood of the transferring probe was attempted. Negative results were obtained. (TTT)

**29700** RADIATION OF AN ELECTRON MOVING IN A SPIRAL IN A MAGNETOACTIVE PLASMA. [PART] III.

V. I. Pakhomov and K. N. Stepanov. Zh. Tekhn. Fiz., 33: 437-43(Apr. 1963). (In Russian)

The magnetic bremsstrahlung and Cherenkov radiation was examined for an electron when the radiation frequency was close to the frequency of the plasma longitudinal oscillations in a magnetic field. When the frequency was close to the value $\omega_2$ then a double resonance takes place, the plasma waves are greatly extinguished and the bremsstrahlung radiation increases sharply. The electron bremsstrahlung was examined for angles where such double resonances exist. It is shown that, when double resonance conditions are met, the bremsstrahlung intensity for electrons with velocities close to the average thermal plasma electron velocity, $v_T$, increases relative to the radiation intensity in vacuum. This increase is by a factor of $1/\beta^{s+1}$, where $\beta = v_T/c$, and $s = 3, 4, \ldots$. The absorption of Cherenkov radiation due to fast electrons in the plasma was also considered. The total losses suffered by a relativistic electron moving in a spiral because of Cherenkov radiation was found to remain always finite. Results were obtained for the radiative and absorptive properties of the plasma for frequencies close to $\omega_2$. (TTT)

**29701** A SOURCE OF MOLECULAR HYDROGEN IONS FOR "OGRA". P. M. Morozov and L. N. Pilgunov. Zh. Tekhn. Fiz., 33: 470-8(Apr. 1963). (In Russian)

The construction of an ion source is described. The source is designed for the injection of $H_2^+$ ions, 200 kev in energy, into a plasma trap of the "Ogra" type. Results are discussed concerning the investigation of the mass spectrum of the hydrogen ions, obtained from the arc discharge of the source. The dependence was determined for this mass spectrum on the different parameters of the arc discharge, on the geometry of the discharge chamber, and on the purity of the hydrogen used. The maximum current of the molecular ions that can be obtained from one of the variants of the gas-discharge head was 1.04 amp for a total ion current of 1.84 amp. (TTT)

## Shielding

*Refer also to abstract 29793.*

**29702** LEAD RADIATION SHIELDING. S. E. van den Broek. Nucl. Energy, 186-91(July 1963).

A survey is presented of the methods used at Graviner Ltd. for the fabrication of lead shielding bricks. The following processes are described: gravity casting, casting and machining, extrusion, and cold pressing. Cold pressing was found to give excellent bricks of no porosity. The specifications and brick sizes of the Harwell shielding system are described. Handling sphere units, window units, and handling tongs are discussed. Finally, the procedures used in the inspection of lead bricks are described. (D.L.C.)

**29703** CONVENTIONAL BUILDING MATERIALS AS PROTECTIVE BARRIERS IN DENTAL ROENTGENOGRAPHIC INSTALLATIONS. E. Dale Trout, John P. Kelley, and Arthur C. Lucas (General Electric Co., Milwaukee). Oral Surg. Oral Med. Oral Pathol., 15: 1211-22(Oct. 1962).

An x-ray unit operating at 70 to 125 kvp, with 0.5 mm aluminum filtration, was used for transmission measurements on various commercial wall structural materials: cinder block with Portland cement or barium mortar and tile facings, gypsum Pyrobar, gypsum plaster on metal lathes, and prefabricated steel. Each wall section was roentgenographed to determine the locations of minimum and maximum shielding. The locations were marked on the wall sections, and transmission measurements were taken at these points. Lead-attenuation data were also obtained, and wall transmission data were converted to lead equivalents, using the lead-attenuation data, and to concrete equivalents. A dental roentgenographic room with some typical barrier protection problems is illustrated and the maximum shielding that would be required in such an installation is discussed. Shielding requirements are shown for several work loads ranging from that encountered in a typical dental office to that of a busy dental roentgenographic installation. Attenuation measurements on the samples made under conditions of narrow-beam geometry indicated that the effective atomic number of all the materials except the barium mortar was sufficiently close to that of concrete to permit the use of the concrete broad-beam mass-absorption coefficient for computing changes in attenuation due to slight changes in the thickness of any one of the component parts of a wall. The results on typical wall sections indicate that conventional walls provide significant and often adequate shielding in the dental voltage range. (TCO)

## Theoretical Physics

**29704** SOME THERMODYNAMIC RELATIONS IN FIELD THEORY. Ju. P. Rybakov (Moscow State Univ.), Compt. Rend., 256: 4857-9(June 5, 1963). (In French)

For the stationary states in nonlinear field theory and for the limiting case of the linear field, it is shown that the problem of the stability or instability can be treated thermodynamically. The Liapounov functional is identified as the free energy of the system. (tr-auth)

# REACTOR TECHNOLOGY

## General and Miscellaneous

*Refer also to abstracts 28918 and 29255.*

**29705** (AEEW-R-288) THE PROBLEM OF REACTIVITY AND REACTION-RATE CALCULATIONS FOR MIXED GRAPHITE LATTICES. H. H. W. Pitcher (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1963. 14p.

The dependence of reactor physics quantities, such as $\eta f$ and $Pu^{239}/U^{235}$ fission ratio, in a single cell on the environment of the cell and the relationship of the reactivity of a mixed lattice to the reactivity of its components in graphite-moderated reactors are investigated. A mixed lattice fueled with uranium at 0 and 3000 Mrd/t showed at 8 cm pitch a small but appreciable change (~1%) in cell quantities, and at 25-cm pitch a smaller change. It is found that the present method of calculating lattice reactivity, ignoring intercell effects, is probably adequate for standard-pitch metal-fueled graphite-moderated systems. More general mixed-lattice systems, particularly if accurate values of cell quantities are required, may need special calculation techniques; these are discussed, and techniques adequate for most systems are presented. (auth)

**29706** (BAW-1271) SPECTRAL SHIFT CONTROL REACTOR BASIC PHYSICS PROGRAM. Quarterly Technical Report No. 10, January–March 1963. (Babcock and Wilcox Co., Lynchburg, Va.). Contract AT(30-1)-2602. 61p.

Work on the nuclear properties of slightly enriched uranium oxide lattices moderated by $D_2O-H_2O$ mixtures is reported. Critical experiments were performed on a perturbed uniform lattice of 2.46%-enriched $UO_2$ fuel rods having a nonmoderator-to-moderator volume ratio of 1.0 and moderated by a 72% $D_2O-H_2O$ mixture. The following perturbations were studied: boral blade in uniform lattice, moderator gap in uniform lattice, boral blade in moderator gap, cadmium blade in moderator gap, aluminum blade in moderator gap, boral cruciform in moderator gap, and aluminum cruciform in moderator gap. In each case the reactivity worth of the perturbation and the local flux distribution were measured. The conceptual design of a series of Small Lattice Experiments (SLE) was completed. The objective of this work is to measure $k_{\infty}$ thermal disadvantage factor, and cadmium ratios of $U^{235}$ and $Th^{232}$ in a lattice of 93%-enriched $UO_2-ThO_2$ ($N_{Th}/N_{25} = 15$) fuel rods. The nonmoderator-to-moderator volume ratio is 1.0, and the moderator composition is 70–80% $D_2O$. Improvements in methods of analysis continued. A program (RIP) for computing near thermal-resonance-and high-energy absorption for use in multigroup codes, particularly BPG, is described. (auth)

**29707** (CISE-94) COCCO BILL: A CRITICALITY CALCULATION CODE (REVISED EDITION). R. Bonalumi and G. B. Zorzoli (Centro Informazioni Studi Esperienze, Milan). May 1963. 82p.

A modified two-group criticality calculation code to be used with the ELEA 6001 Olivetti digital computer is described. This program, a revised and improved version of a previous one with the same name, gives as outputs all microscopic and macroscopic lattice parameters concerning criticality calculation on heavy water or graphite moderated reactors, with the fuel elements in cylindrical or clustered geometry. The program, planned in view of parametric studies, allows criticality studies to be carried out for several lattices in a single machine run. (auth)

**29708** (EUR-197.f) LA SIMULATION DYNAMIQUE A TROIS DIMENSIONS DES GRANDS RÉACTEURS NUCLÉAIRES. (Three-Dimensional Dynamic Simulation of Large-Scale Nuclear Reactors). H. d'Hoop (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy and European Atomic Energy Community. European Scientific Data Processing Center, Ispra, Italy). 1963. 23p. (CETIS-18)

An analog simulation of a reactor by separation of variables is described. The flux diffusion is represented by transforming the Laplacian operator into a spectrum of orthogonal eigenfunctions. Thermal phenomena are represented by the finite difference approximation, since temperature does not have the same boundary conditions as a neutron flux. In order to simulate the interactions between flux and temperatures, and the action of control rods, a hydrid representation in two configuration spaces is used. Each set of variables is represented in both forms by linear transformation. (auth)

**29709** (GEAP-3819) PROBABILITY THEORY AND REACTOR CORE DESIGN. Frederick J. Moody (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 1962. Contract AT(04-3)-361. 119p.

Probability theory was applied at the design stage to predict randomness of properties in an operating core. Design variables whose randomness was significant were assumed to be independent of each other. Results indicated the degree of conservatism in the design. The theory can be applied to designs to select particular values of the design parameters so as to give a prescribed degree of conservatism (confidence level). Application of the theory provides probability functions and cumulative probability distributions for important thermal-hydraulic properties in an operating core. Confidence limits may be stated directly from these. An application of this theory was made to the AEC-Consumers R & D Project 300 Mw(e) HPD Conceptual Design Study. General methods are suggested for the optimization of core parameters using probability theory. (auth)

**29710** (GEAP-4092) DOPPLER CALCULATIONS FOR LARGE FAST CERAMIC REACTORS— EFFECTS OF IMPROVED METHODS AND RECENT CROSS SECTION INFORMATION. P. Greebler and E. Goldman (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Dec. 19, 1962. Contract AT(04-3)-189. 88p.

Doppler calculations for large fast ceramic reactors (FCR), using recent cross section information and improved methods, are described. Cross sections of $U^{238}$, $Pu^{239}$, and $Pu^{240}$ with fuel temperature variations needed for perturbation calculations of Doppler reactivity changes are tabulated as a function of potential scattering cross section per absorber isotope at energies below 400 kev. These may be used in Doppler calculations for any fast reactor. Results of Doppler calculations on a large fast ceramic reactor are given to show the effects of the improved calculation methods and of recent cross section data on the calculated Doppler coefficient. The updated

methods and cross sections used yield a somewhat harder spectrum and accordingly a somewhat smaller Doppler coefficient for a given FCR core size and composition than calculated in earlier work, but they support the essential conclusion derived earlier that the Doppler effect provides an important safety advantage in a large FCR. 28 references. (auth)

**29711** (GEAP-4130) EXPERIMENTAL STUDIES OF TRANSIENT EFFECTS IN FAST REACTOR FUELS. SERIES I. $UO_2$ IRRADIATIONS. J. H. Field (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Nov. 15, 1962. Contract AT(04-3)-189. 79p.

An experimental program to evaluate the performance of FCR and EFCR fuel during transient operation is outlined, and the initial series of tests are described in some detail. Test results from five experiments in the TREAT reactor, using 1-in. OD SS-clad $UO_2$ fuel specimens, are compared with regard to fuel temperatures, mechanical integrity, and post-irradiation appearance. Incipient fuel pin failure limits for transients are identified with maximum fuel temperatures in the range of 7000°F. Multiple transient damage to the cladding is likely for transients above the melting point of the fuel. (auth)

**29712** (GEMP-77) REACTOR INSTRUMENTATION AND CONTROL PROGRESS REPORT NO. 77. (General Electric Co. Advanced Technology Services, Cincinnati). May 31, 1963. Contract AT(40-1)-2847. 43p.

CIRCULATING-BALL REACTIVITY CONTROL. Wafer-type, and copper-sleeved drive rods were tested in a modified electromagnetic unit having wide-faced pole pieces and coils. A preliminary shim-scram actuator driven by electromagnetic units, with a hydraulic shim-rate limiter in the withdrawal direction, was assembled and operated to demonstrate feasibility, and to aid in the design of a prototype actuator. STATIC SWITCHING. The control circuit for the linear induction-motor was modified for operation into a 3-phase 4-wire wye-connected linear induction-motor. The basic scram circuit was modified to work with the control circuit to provide a combination shim and scram control. CAPACITANCE TEMPERATURE SENSOR. Work was performed on the exploration of maximum operating temperatures of alumina and beryllia, the fabrication and initial testing of a molybdenum-beryllia shielded-probe assembly, development of a transistorized transmission system, and the investigation of sensor-cable length effects. HIGH-TEMPERATURE EXTENSION OF CONVENTIONAL NUCLEAR SENSORS. Testing of fission counters and fission-counter components to 1500°F, d-c ionization chambers to 1000°F, and ionization chamber components to 1200°F was continued. DEVELOPMENT OF NUCLEAR SENSORS. Several high-temperature gridded a-c ionization chambers were built and tested. A cylindrical gridded chamber was designed and built for operation at low temperatures. The design of a 1000°F cylindrical chamber was completed. A charged-fragment neutron detector containing a grid structure for capturing emitted secondary electrons was constructed. A charged-fragment detector was designed with a gold plating on the boron-10-coated cathode to absorb the emitted alpha particles. (B.O.G.)

**29713** (IDO-16893) SPERT PROJECT QUARTERLY TECHNICAL REPORT, JANUARY–MARCH 1963. F. Schroeder, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). May 20, 1963. Contract AT(10-1)-205. 54p.

Additional data from the 3.2-msec-period destructive test were analyzed. Recovery and cleanup operations in the Spert I area were completed. Each of the 270 highly enriched, aluminum-clad fuel plates in the core was found to have experienced melting to some degree. The available data on the nature of the pressure pulse and on the condition of the core fuel plates at the time of the pulse are consistent with the hypothesis that the observed destructive effects were produced by a self-propagating steam explosion resulting from the dispersal of molten fuel plates into the water throughout the core. A series of tests was initiated to determine the response of the Spert IV plate-type core to step-inputs of reactivity at ambient temperature, for various initial system conditions of hydrostatic head above the core, and forced coolant circulation rate. Power excursion tests with initial reactor periods in the range from 1 sec to 8.5 msec were performed with an 18-ft hydrostatic head above the core and no forced coolant circulation. Tests with periods of 20, 12, and 8.5 msec were also performed with a 2-ft head. No significant change was observed in the peak power, power burst shape, energy release, or transient pressure behavior as a result of the head change. The fuel plate surface temperatures were slightly higher for the 18-ft head tests. Tests with periods in the range from 500 to 10 msec were performed with a forced coolant flow rate through the core of 5000 gpm (12 ft/sec) with the 18-ft hydrostatic head. For tests with periods longer than about 100 msec, the addition of forced flow tends to eliminate the initial power peak and to increase the equilibrium power level. For shorter-period tests, the initial power peak is increased slightly when flow is added, but the effect decreases as the period is shortened. A series of damped secondary power bursts is observed in the short-period tests with flow. Fuel plate surface temperatures are reduced by the addition of flow for long-period tests, but for tests with periods shorter than about 30 msec, the available 12 ft/sec flow velocity had little effect on the temperatures. Four-group, one-dimensional diffusion theory calculations were performed to provide preliminary information pertinent to the selection of specifications for low-enrichment, oxide fuel rods to be used in planned future test programs in Spert III and Spert IV. Data from a series of high-power pile-oscillator experiments previously conducted in Spert I with the P-18/19 core at a mean power level of 400 kw and a bulk-water temperature of 66°C were processed to extract the phase and amplitude of the over-all frequency response of the system. The departure of the measured high-power transfer function from the theoretical low-power transfer function is significant only for frequencies below about 1 cps. Computational procedures were developed to calculate the feedback transfer function directly from the measured step-transient power response of the reactor. (auth)

**29714** (KR-43) INVESTIGATIONS IN SPATIAL REACTOR KINETICS. P. T. Hansson and L. R. Foulke (Norway. Institutt for Atomenergi, Kjeller). Apr. 1963. 45p.

Measurements of the spatial dependence of the zero power transfer function of NORA were performed, using a local reactivity perturbation. Significant spatial effects were found for frequencies higher than the break frequency $\beta/l$, and the wave-nature of the flux space-time variation was recognized. A theoretical interpretation based on two-group diffusion theory is given, solving the equations in the finite difference approximation on an analogue computer. In general, there is good qualitative agreement between theory and experiments. (auth)

**29715** (LA-2735 Revisions) FAST REACTOR CORE TEST FACILITY SAFETY ANALYSIS REPORT. (Los

Alamos Scientific Lab., N. Mex.). Apr. 18, 1963. Contract W-7405-eng-36. 28p.

Changes made in the Fast Reactor Core Test Facility include the reduction in the size of static pressure control blowers for ventilation system No. 2 and the addition of automatic opening of the line which bypasses these blowers when system pressure is above atmospheric pressure. A deep-bed dynel filter was added just upstream of each carbon filter (iodine trap) for the purpose of removing sodium oxide smoke. Revisions to the safety analysis report are listed. (M.C.G.)

**29716** (MITNE-34) MODIFICATIONS TO FUEL CYCLE CODE "FUELMOVE." J. A. Sovka and M. Benedict (Massachusetts Inst. of Tech., Cambridge). Apr. 15, 1963. Contract AT(30-1)-2073. 44p. (NYO-9717)

Modifications were made to the fuel cycle code FUELMOVE to enable calculations to be made upon reflected reactors without the use of the "reflector savings" approximation. The modified code, called FUELMOVE II, is able to obtain thermal flux distributions in both the fuel-bearing regions and the reflector for batch and steady-state bi-directionally fueled reactors. Also, reactivity control for batch fueling can now be achieved by the use of a soluble poison in the reflector and moderator in addition to the methods of fixed poison in the core, control rods, and burnable poison. The natural-uranium-fueled, heavy-water-moderated, and pressurized-heavy-water-cooled CANDU reactor was used to test out the changes. Comparisons of results of fuel burnup and flux and power distributions with previously obtained results showed close agreement. Included is a description of the programming changes made to the code. (auth)

**29717** (NAA-SR-Memo-7844) SINGLE ELEMENT SHIPPING CASK FOR PNPF, OMRE, AND EOCR IRRADIATED FUEL ELEMENTS. C. Jones, D. Lew, K. Adler, and J. Marron (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 7, 1963. Contract AT(11-1)-Gen-8. 87p.

A shipping cask system was designed for shipping one fuel assembly from either the EOCR, OMRE, or Piqua Reactor plants. The shipment will be dry without liquid coolant between the cask and the fuel element shipping container after 30 days decay. Shielding is designed to limit radiation from the cask to 10 mr/hr at one meter from the cask surface and 200 mr/hr on contact with any point on the cask exterior surface. System description, general calculations, fire test analysis, shielding analysis, criticality analysis, thermal analysis, stress analysis, loading and unloading procedures, and test program are included. (M.C.G.)

**29718** (NAA-SR-Memo-8456) ENERGY RELEASE IN AN HNPF UC FUEL SLUG IN TREAT, AND NUCLEAR EFFECTS OF THE TEST ON THE TREAT CORE. J. M. Otter (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 30, 1963. Contract AT-11-1-GEN-8. 11p.

Calculations of the energy release per unit volume of the fuel slug per total energy release in the Treat core are described. For a 1000 Mw-sec release in Treat, values of $98{,}200/V_{TR}$ and $89{,}400/V_{TR}$ (Mw-sec)/cc, where $V_{TR}$ is the volume of the Treat core, were obtained, respectively, for 4.9 and 3.7% $U^{235}$ UC fuel slugs in the center of the Treat core. The nuclear effects of the experiment on Treat performance are found to be minor even in extreme circumstances. The only notable effect is the gross reactivity change of −2% from replacing the central dummy element of the reactor with the experiment. (auth)

**29719** (NAA-SR-Memo-8529) THERMAL ANALYSIS OF THE SGR MARK IV CONTROL ROD ABSORBER ASSEMBLY. C. G. Johnson and G. C. Burry (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 1, 1963. Contract AT-11-1-GEN-8. 57p.

A one-dimensional heat transfer parameter study conducted on the Mark IV $Dy_2O_3$ control rod with absorber thicknesses of $\frac{1}{8}$, $\frac{1}{4}$, and $\frac{3}{8}$ inch and an inside Hastelloy-X clad thickness of $\frac{1}{16}$ inch revealed that the clad temperature limit of 1800°F would be exceeded in the linear heat rate range of interest for this control rod. These conclusions were based upon a constant helium gap thickness of 28 mils and a $Dy_2O_3$ thermal conductivity of 0.6 Btu/hr-ft-°F. Although there is some uncertainty associated with the magnitude of $Dy_2O_3$ thermal conductivity, the use of an optimistic value of 1.0 Btu/hr-ft-°F would only permit a linear heat rate of 6.3 kw/ft for a $\frac{1}{8}$-inch absorber thickness and a 1800°F clad temperature limit, which is substantially below the expected heat rate for the 525 Mw(e) SGR. By replacing the inner clad with a solid graphite cylinder and making the outer clad the structural support member of the element, the clad temperature limitation is shifted to the much cooler outer clad rather than being set by the inner clad, and higher permissible linear heat rates are possible. This became the basis of the second design. Taking into account radiation, conduction, and the combined effect of differential expansion and temperature dependent conductivities upon the temperature distribution within the $Dy_2O_3$ rod, allowable linear heat rates of 6.3, 10.8, 14.9, and 20.6 kw/ft were determined for the 0.187-inch thick $Dy_2O_3$ rod having initial cold radial helium gaps of 61, 45, 35, and 27.5 mils, respectively. These corresponding gaps under the hot thermal-expanded condition became 55, 37.6, 27.7, and 20.2 mils, respectively. Therefore, assuming uniform heat generation and no axial conduction, a control rod having a local cold gap restriction of 35 mils could dissipate a peak linear heat rate of 14.9 kw/ft. The results of a one-dimensional thermal analysis on the Haynes 25 control rod with absorber thicknesses of $\frac{3}{8}$, $\frac{3}{4}$, and 1-inch are given. For the $Dy_2O_3$ and Haynes-25 rods there exists a substantial incentive from a heat transfer viewpoint to reduce the initial helium gap as much as possible within practical design limits. The one-dimensional thermal analysis on the Haynes-21 control rod of $\frac{3}{8}$-inch thickness indicated that a peak linear heat rate of 20.4 kw/ft as calculated from estimates of neutron and gamma heating would produce a maximum temperature of 1912°F for a 35 mil initial cold gap. Under the same conditions, but taking into account axial conduction, the maximum temperature decreased to 1827°F. Thus, axial conduction results in an 85°F drop in maximum temperature for this heat rate. In general, the basic assumptions of uniform heat generation and no axial conduction are conservative and result in higher calculated temperatures for the one-dimensional solutions presented. (auth)

**29720** (NYO-2483) THE PERFORMANCE AND CHARACTERISTICS OF THE MILLETRON TRANSFER FUNCTION COMPUTER. N. B. McLeod (Nuclear Utility Services, Inc., Washington, D. C.) and M. A. Schultz (Milletron, Inc., Irwin, Penna.). May 1963. Contract AT(30-1)-2898. 40p.

The characteristics, performance, and use of Milletron, an automatic analog computer device for deriving the power spectrum of a reactor from the neutron noise as obtained with an ionization chamber, is discussed. Operational principles and theory are examined; and spectra obtained for the Oak Ridge Reactor, and their interpreta-

tion, are included. Derivation of transfer functions with Milletron is also considered. (D.C.W.)

**29721** (NYO-10574) EVALUATION OF AUTOMATIC FLOW BALANCING DEVICE IN BOILING WATER REACTORS. Quarterly Progress Report, April–June 1963. Report No. 412. R. L. Mela, D. A. Gall, and E. F. Doyle (Dynatech Corp., Cambridge, Mass.). July 10, 1963. Contract AT(30-1)-2907. 20p.

The test section and high pressure loop designs are described. Progress on the construction of the overall system is discussed. A schedule for the completion of the program is included. (auth)

**29722** (PAN-409/IX) IN-CORE NEUTRON FLUX DISTRIBUTION MEASUREMENTS. Lesław Adamski and Krystyna Józefowicz (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Mar. 1963. 13p.

Presented at Conference on Reactor Physics and Engineering, Prague, April 1963.

The simple method of in-core neutron flux distribution measurements was developed using copper wires activated in the measured area. The activity distribution along the wire was measured continuously, or the wire was cut into the small pieces and their activities were measured. A 2 π proportional flow-type counter, G-M counter, and scintillation counter were investigated as the counting devices. The G-M counter gave the best signal-to-background counts ratio and a good efficiency. The G-M window counter and the scintillation counter with NaI (Tl) well-type crystal were used for activity measurements of wire pieces. The scintillation counter efficiency was better by a factor of 5 than that of the G-M counter. This method can be used for neutron flux greater than $10^5$ n/cm$^2$ sec. (auth)

**29723** (PAN-418/XII) STRUKTURA "MAXTREL" SYSTEMY UPRAVLENIYA I ZASHCITY YADERNOGO REAKTORA. (The "Maxtrel" Control and Safety System for Nuclear Reactors). N. Filipczak (Nadekhda Filipchak) and W. Filipczak (Veslav Filipchak) (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Mar. 1963. 33p.

Presented at Conference on Physics and Reactor Technology, Prague, April 1963.

The reliability of control and safety systems are analyzed. The structure of reliable control and safety systems with small values of dead time is determined. Due to this structure the reliability of the system is reduced to the reliability of safety elements, for instance ordinary relays. The criteria for optimum structure from the economical point of view are given. The reactor control and safety system Maxtrel is discussed. (auth)

**29724** (RM-3089-PR) A SIMPLE METHOD OF DETERMINING THE EFFECT OF REACTOR TEMPERATURE ON CRITICALITY CONDITIONS. B. Pinkel, A. Leonard, and G. B. W. Young (RAND Corp., Santa Monica, Calif.). June 1963. Contract AF49(638)-700. 40p.

An analysis is made of the effect of reactor temperature on criticality conditions, and simple relations are obtained for calculating these effects. The buckling (and hence reactor size for criticality) may be expressed as a function of the fission, capture, and scatter cross sections of the reactor materials averaged over the flux spectrum. If these parameter averages are known for one reactor temperature, then the simple relations derived allow computation for other reactor temperatures. A substantial simplification of the analysis results from the assumption that the major part of the influence of reactor temperature comes from the changes in the cross sections and in the values of the flux distribution in the vicinity of thermal energy. Good agreement is obtained between the values computed from the equations and the values obtained from an 18-group machine calculation performed for a series of reactors covering a temperature range from 25 to 1450°C. (N.W.R.)

**29725** (RT/EL(63)4) UN CONVERTITORE ANALOGICO-NUMERICO TRANSISTORIZZATO PER ELABORAZIONE DI DATI DI IMPIANTI NUCLEARI. (Transistorized Analog-Digital Converter for Elaboration of Nuclear Plant Data). R. Marconero (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Elettronica, Rome). Mar. 1963. 13p.

A design of analog-digital converter completely transistorized, developed by the CNEN Electronic Laboratory, is described. The proposed device is designed for general purpose use and for systems of nuclear plants elaboration data. (auth)

**29726** (RT/ING(63)6) L'AVVELENAMENTO DA XENON NELLE DIFFERENTI CONDIZIONI DI FUNZIONAMENTO DEI REATTORI NUCLEARI. (Xenon Poisoning Under Different Operating Conditions in Nuclear Reactors). G. Galuppini and L. Sani (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Mar. 1963. 50p.

The variation of $Xe^{135}$ concentration following a change in reactor power is studied. The possibility is examined of programming both a power decrease and a complete shutdown to reduce, consistently with the amount of available reactivity, the xenon poisoning effects and also to regulate the power increase after the reactor shutdown, so that the rapidity of xenon burnout, and consequently of reactivity build-up, may not be harmful to the nuclear plant safety. (auth)

**29727** (TID-18967) COMPARISON OF THE WORTH OF CRITICAL AND EXPONENTIAL MEASUREMENTS FOR HEAVY WATER MODERATED REACTORS. W. E. Graves and E. J. Hennelly (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). July 1963. Contract AT(07-2)-1. 50p.

Operation of critical, exponential, and pressurized-exponential heavy-water-moderated reactors is described. The applicability of these facilities in the following fields of reactor experimentation is discussed: buckling measurements in uniform lattices; anisotropic and void effects; evaluation of control systems; temperature coefficients; mixed lattices; and subcriticality studies of fuel for heavy-water-moderated reactors. (M.C.G.)

**29728** (UCRL-7007) FISSION DISTRIBUTION IN SEVEN-PIN CLUSTER FUEL ELEMENTS. R. Gordon, V. E. Schrock (California. Univ., Berkeley); R. N. Stuart, and A. J. Kirschbaum (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 12, 1962. Contract W-7405-eng-48. 26p.

The distribution of fissions within one fuel pin of a cluster is asymmetrical because of self-shielding and neutron-streaming phenomena. An implicit solution of the integral form of the Boltzmann equation indicates that, for a given neutron spectrum, this distribution is primarily a function of three dimensionless parameters: pin radius/neutron mean free path in pin material; pin circle radius/pin radius; and pin radius/fuel element radius. The actual distribution was determined experimentally by detector foils and autoradiographic techniques for various seven-pin, cluster-type, gas-cooled fuel elements. The experimental fuel pins were fabricated by winding alternate 0.001 inch

thick layers of pure aluminum and enriched uranium (93% $U^{235}$) on a solid core until the desired pin diameter was reached. Seven of these pins, assembled into a fuel element, were irradiated in the thermal column of a research reactor. The layers of uranium and the uranium detector foils (which were exposed concurrently) were subsequently autoradiographed and the resulting x-ray film optical density measured on a microdensitometer. The detector foils were also counted in a gamma detector, thus providing a key between relative radioactivity and optical density. It was found that the fission distribution within the center pin of the cluster was symmetrical and could be represented by $D = D_1 \exp [C_1 (x^2 + y^2)]$. The fission distribution in the outer pins of the cluster was asymmetrical with respect to the pin center but could be represented by $D = D_2 \exp [C_2 (x^2/g^2 + (y - y_s)^2]$. Values of the constants in the equations are correlated by the first two dimensionless parameters given but appear to be independent of the third. (auth)

**29729** ON THE TIME-DEPENDENT FLUX DISTRIBUTION OF A FIXED-FUEL THERMAL NUCLEAR REACTOR. Paul L. Chambré and Lawrence M. Grossman (Univ. of California, Berkeley). Appl. Sci. Res., Sect. A, 11: 387-96(1963).

An analytical method is presented for determining the flux distribution and reactivity in a bare homogeneous thermal nuclear reactor during fuel burn-up. It is shown that these two functions can, in principle, be calculated from a recursive set of differential equations. The analysis is illustrated for the case of a flat-plate reactor. (auth)

**29730** SPHERICAL HIGH-TEMPERATURE FUEL ELEMENT. L. Rachor, G. Spener, and B. Leibmann (Nuklear-Chemie und-Metallurgie GmbH, Wolfgang, Ger.). Atomwirtschaft, 8: 370-1(June 1963). (In German)

Considerable resources are being devoted in the USA and Great Britain to the development of high temperature fuel elements which contain the fuel in the form of coated particles. It is difficult in the case of spherical fuel elements to introduce the particles undamaged into a graphite matrix and to attain at the same time the required consistency. A process was developed in which the particles are introduced as a thin layer on the inner wall of a hollow sphere of electrographite. The internal surface of the sphere is provided, for example, with a very thin layer of a highly adherent graphite on which the particles are uniformly distributed by sprinkling. The essential advantage of the hollow sphere concept as compared with pressed elements lies in a lowering of the fuel temperature. (auth)

**29731** THE PREVENTION OF FISSION PRODUCT ESCAPE FROM NUCLEAR REACTORS. D. A. Collins. Nucl. Energy, 180-5(July 1963).

It is concluded that an absolute guarantee of safety in all conceivable circumstances is as unattainable for nuclear reactors as it is for any other large-scale engineering enterprise. However, increasing knowledge of the behavior of released fission products causes growing confidence that their escape can be controlled with certainty by installing trapping systems, so that safe reactor design reinforced by such measures seems likely to provide the assurances which could lead to relaxation in siting requirements. The experience being gained in proving fission product trapping systems for the AGR leads to the belief that alternative forms of containment can be developed. (auth)

**29732** EXPERIMENTAL DETERMINATION OF THE p-FACTOR OF REACTOR LATTICES WITH THE HELP OF THE ARGONAUT REACTOR. Wolf-Heiner Dio, Arnold E. Gruen, and Werner Oldekop (Siemens-Schuckertwerke AG, Erlangen, Ger.). Nukleonik, 5: 163-70(June 1963). (In German)

The resonance transmission probability p in reactor lattices can be determined by measurement of the thermal and epithermal capture rate in $U^{238}$, if the f factor of the lattice and the thermal cross section of the fuel are known. It was shown experimentally that this method is also usable for small lattice sections consisting of only seven cells, if these sections are inserted as lattice insertions in the ring core of the Argonaut Reactor. The neutron spectrum in the insert is approximated by a water layer situated between the ring core and the lattice insert for the characteristic spectra of the investigated lattice. The remaining variations in the spectra were ascertained and eliminated by measurement of thermal and epithermal leak factors. Measurements were carried out on a graphite lattice with individual metallic rods of uranium and of a typical $D_2O$ lattice with bundled $UO_2$ fuel elements. The results were compared with theoretical calculations of the p factor. It is shown that the limits of error of the method are smaller than the uncertainty in the calculation of p for complicated fuel elements. Various measuring problems are discussed. (tr-auth)

**29733** NEUTRON LIFETIME AND REACTIVITY MEASUREMENTS IN THERMAL REACTORS WITH THE HELP OF THE ROSSI-$\alpha$-METHOD. Theodor Stribel (Siemens-Schuckertwerke AG, Garching, Ger.). Nukleonik, 5: 170-3(June 1963). (In German)

Rossi $\alpha$-measurements on two thermal reactors, the Siemens Instruction Reactor (SUR) and the Siemens Argonaut Reactor (SAR), are reported. Methods and equipment are described and the results presented. For the SUR an average neutron lifetime of $48.75 \times 10^{-6}$ sec (with $\beta_{eff} = 7.4 \times 10^{-3}$) was obtained, for SAR a lifetime of $173.6 \times 10^{-6}$ sec (with $\beta_{eff} = 8.5 \times 10^{-3}$) was determined. Reactivity measurements on the basis of the $\alpha$-method agreed satisfactorily with those obtained by the "rod-drop" method. The statement concerning the size of the time-dependent part of the frequency distribution, which is supplied by theory in the energy and place independent region, could not be confirmed. (tr-auth)

**29734** THE INTEGRAL FORMULATION OF THE REACTOR KINETICS EQUATIONS. Aldo Belleni-Morante (Università, Firenze, Italy). Nukleonik, 5: 183-4(June 1963). (In English)

It is shown that the nuclear reactor kinetics equations may be written in the form of an integral equation of the Volterra type. (auth)

**29735** A MANUAL OF EXPERIMENTS IN REACTOR PHYSICS. Frank A. Valente, ed. (Rensselaer Polytechnic Inst., Troy, N. Y.). New York, The Macmillian Co., 1963. 347p. $7.50.

Presented are 23 experiments in reactor physics, which are divided into three groups according to apparatus required: experiments requiring a subcritical assembly and a steady source of neutrons; and experiments requiring a sigma pile or a subcritical assembly and a pulsable source of neutrons. The remaining six chapters are intended to provide a minimum of essential, at-hand information appropriate to the experiments discussed. These six chapters cover: statistics; radioactivity; instrumentation; pulsed-neutron techniques; health physics; and an introduction to the experiments. (B.O.G.)

**29736** NUCLEAR FUEL ELEMENT CASINGS. Marc Salesse and Jacques Andre Stohr (to Commissariat à l'Énergie Atomique). British Patent 895,076. May 2, 1962. Priority date Dec. 5, 1958, France.

A nuclear fuel element casing with helical fins is patented. The casing consists of a cylindrical body with fins that form sets of helical segments around the body. The helical segments in a set are parallel to one another and extend longitudinally along the body. The direction of the helices in one set is opposite to that of the adjacent set. The fins in one set are connected to the fins in adjacent sets to form complete herring bones around the body of the casing. The casing has the advantages of a large exchange surface and a high coefficient of heat exchange. Variations in the geometry of the fins are described. (M.P.G.)

**29737** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. William Selwyn Robson (to United Kingdom Atomic Energy Authority). British Patent 924,847. May 1, 1963. Filed Mar. 27, 1961.

The design of a fuel element assembly consisting of a cylindrical graphite sleeve, which supports a sheathed fuel element, is patented. The sheath of the cylindrical fuel element has helical heat-transfer fins and longitudinal coolant separator fins extending beyond the helical fins. The graphite sleeve has grooves on its internal surface, which engage the longitudinal fins on the sheath, preventing relative rotation of the sleeve and the sheath. (M.P.G.)

**29738** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. John Matthewson Miller (to Babcock and Wilcox Ltd.). British Patent 925,231. May 1, 1963. Filed Aug. 18, 1958.

The design of a fuel-element can is patented. The can has extended heat-exchanging surfaces, which may be helical. Projecting radially beyond the heat-exchanging surfaces are a plurality of planar fins, which are distributed around the can and extend lengthwise of the can. The part of the fins that projects beyond the heat-exchanging surfaces is provided with lateral projections to induce turbulence in a stream of coolant flowing past the can. The projections on a fin are separated from each other and their extension from the plane of the fin increases with the radial distance from the can. The surface of a projection may be the minor part of the surface of a cone, and the projections may be formed by deflecting fin material out of the plane of the fin. (M.P.G.)

**29739** NUCLEAR REACTOR CONTROL SYSTEM. Seymour Oestreicher (to American Machine and Foundry Co.). British Patent 925,298. May 8, 1963. Filed Dec. 30, 1959.

The design of a system of control rods and control-rod driving mechanisms interchangeably mounted about a reactor core is patented. A number of demountable control mechanisms, each having a control rod and a control-rod driving means, are mounted on a grid plate, which serves as a supporting member. The mechanisms can be fastened to the plate in many places. The control-rod driving means has interchangeable components, such as gears and motors, to vary speed, motive power, and precision of control of control-rod movements. The invention can be used in many kinds of reactors, and provides a flexible control system so that reactors can be modified to meet changing experimental needs. (M.P.G.)

**29740** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Leslie Reginald Blake (to United Kingdom Atomic Energy Authority). British Patent 925,426. May 8, 1963. Filed Oct. 4, 1960.

The design of a sheathed fuel element, which is especially applicable for use in fast reactors, is patented. Each fuel section consists of a sheath filled with fuel only to 50 to 90% of the available fuel volume. The fuel sections are arranged end to end in an outer sheath, which has flattened sides to come in direct contact with the inner sheaths. The spaces where the sheaths are not in direct contact are filled with a thermally bonding material. The outer sheaths have radially projecting longitudinal fins extending over the length of the element. These fins engage the fins of adjacent elements forming a fuel element assembly chargeable into a reactor as a single unit and composed of several fuel elements in spaced parallel relationship. (M.P.G.)

**29741** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. George Howard Forsyth (to Vickers-Armstrongs (Engineers) Ltd.). British Patent 925,747. May 8, 1963. Filed Nov. 25, 1960.

A design of a boiling-water reactor using either light or heavy water or a mixture as moderator is patented. Above the core of the reactor is a steam space, in which steam produced by the boiling moderator accumulates. A steam circulating system draws steam from the steam space and circulates it through the reactor core. A valve is provided to divide the steam between a load line and the reactor core. A by-pass valve controls the working pressure of the reactor, opening to circulate more steam to the core when the working pressure of the reactor increases, so that the neutron flux is reduced and the pressure falls. The steam recirculated through the reactor core is supplied more to the center of the core than to the periphery to achieve flux flattening. A mechanism is also provided to withdraw the control rods from the core progressively during the life of the core to adjust for burn up. (M.P.G.)

**29742** HOMOGENEOUS NUCLEAR REACTOR. (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 925,748. May 8, 1963. Priority date Dec. 1, 1959.

A design of a boiling homogeneous reactor is patented. The reactor has a pressure casing and a container within the casing for the boiling fuel-water mixture. The space between the casing and the inner container forms an annular chamber containing the heavy water reflector. The top of the fuel container is open and connects with the annular chamber through a vapor space in the upper part of the pressure casing. The walls of the fuel container are high enough to prevent the boiling fuel-water mixture from flowing into the annular chamber. The vapor from the boiling fuel-water mixture is condensed by a heat exchanger, and the condensate flows into the annular chamber to serve as reflector and is then returned to the fuel container through an opening in the bottom of the container. Variations in the design are discussed, including a reflector zone divided into two parts. (M.P.G.)

**29743** IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Frederick Owen Fletcher and Alan Frederick Taylor (to United Kingdom Atomic Energy Authority). British Patent 925,863. May 8, 1963. Filed Mar. 24, 1961.

A sheathed reactor fuel element with end caps sealed to the sheath by edge welds is patented. Each end cap weld is covered by a shroud member sealed to the sheath by a circumferential edge weld. Close to the circumferential edge weld, circumferential ridges on the sheath and

shroud member project radially by at least the amount of projection of the edge weld. The shroud member on one end of the fuel element has a cup-like recess, and the shroud member on the other end has a complementary cone-like projection to permit a column of fuel elements to be end-stacked in a reactor fuel channel. (M.P.G.)

**29744** IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. William Paul White (to United Kingdom Atomic Energy Authority). British Patent 926,053. May 15, 1963. Filed Nov. 15, 1960.

A fuel element having an end coupling for connecting the fuel element to similar fuel elements is patented. The coupling permits the fuel elements to be charged into the reactor as an assembly of connected elements and discharged individually. The coupling consists of a transverse pin and a bayonet-type socket, which releases the pin by rotation of the socket as the pin and socket move towards each other. Another means of coupling consists of a boss and spring-loaded chuck jaws. The jaws engage the boss when the assembly is suspended from its upper end, and release the boss when the fuel elements move towards each other. (M.P.G.)

**29745** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Anthony John Michael Hitchcock (to United Kingdom Atomic Energy Authority). British Patent 926,133. May 15, 1963. Filed Oct. 28, 1958.

A reactor control rod, the neutron-absorbing effect of which increases gradually over its length, is patented. The rod is supported at one end and free at the other end, and its neutron-absorbing effect increases from a low value at the free end, which is inserted into the core of the reactor, to a high value at the supported end. The variation in absorptivity can be achieved by physically tapering the rod or by composite construction of the rod. The composite rod would have four sections along its length, a thin-walled mild-steel tube, a thin-walled boron-steel tube, a thick-walled boron-steel tube, and a thick-walled boron-steel tube filled with graphite. The length of the tapered rod should be greater than the depth of the core structure, so that the control rod extends across the core at all positions. (M.P.G.)

**29746** IMPROVEMENTS RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Leslie Reginald Blake (to United Kingdom Atomic Energy Authority). British Patent 926,344. May 15, 1963. Filed Mar. 28, 1961.

The design of a metallically sheathed reactor fuel element with improved heat-transfer characteristics between the fuel and the sheath is patented. The cylindrical fuel segments are slotted along their length to their center before sheathing. The void is filled with a compressible medium such as a gas that is inert towards the fuel. The fuel segments may have a slight interference fit with the sheath. The slotting gives radial elasticity to the fuel section, easing the pressure of the fuel against the sheath as the fuel expands. (M.P.G.)

**29747** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Piyatilleke Perera Guneratne (to United Kingdom Atomic Energy Authority). British Patent 926,602. May 22, 1963. Filed Feb. 1, 1961.

A hollow fuel element, which is formed from two blind-ended tubes internally braced by a sleeve member, is patented. The sleeve member is a Zr tube with an external screw thread, which engages internal screw threads inside the hollow fuel tubes. The sleeve is inserted in the tubes before they are welded together and assists in joining as well as bracing them. In an alternative design, the fuel tubes are shrunk onto the Zr sleeve before welding instead of being screwed on. (M.P.G.)

**29748** IMPROVEMENTS RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Brian John Darlaston (to English Electric Co. Ltd.). British Patent 926,628. May 22, 1963. Filed Oct. 22, 1958.

A method of closing the end of a tubular fuel-element can containing fissile material and filler gas is patented. The can is closed by an end plug, which is an interference fit in the bore of the can. The plug is cooled until it can be inserted in the can. When the plug becomes the same temperature as the can, it seals the can and prevents gas from leaking in or out. The can is then permanently sealed by welding the joint between the plug and the can. In one method of carrying out the invention, the can is evacuated and filled with helium at low pressure while the end plug is being cooled. (M.P.G.)

**29749** IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Roger Martin (to Commissariat à l'Énergie Atomique). British Patent 927,043. May 22, 1963. Priority date Oct. 18, 1958, France.

A new method of connecting solid moderator bars in a reactor is patented. The bars are hexagonal in cross section, with vertical grooves in at least three angles of the hexagon. Connecting members with at least 3 radially extending arms engage a groove in three laterally adjacent moderator bars and also join two vertically adjacent bars. Free space is left at the bottom of each groove for expansion when the reactor is operating. The stack of moderator bars also contains distance pieces for keeping the bars at a predetermined distance. Variations in the geometry of the moderator bars, connecting members, and distance pieces are described. (M.P.G.)

**29750** IMPROVEMENTS IN OR RELATING TO CONTROL APPARATUS FOR NUCLEAR REACTORS. Jack Jones (to United Kingdom Atomic Energy Authority). British Patent 927,438. May 29, 1963. Filed Jan. 29, 1960.

Control apparatus, which circulates a neutron-absorbing liquid within a reactor core, is patented. The reactivity of the reactor is varied by varying the concentration of the absorber in the liquid. Details of the invention are described. (M.P.G.)

**29751** IMPROVEMENTS IN OR RELATING TO COOLANT CIRCULATING SYSTEMS FOR NUCLEAR REACTORS. (to Escher Wyss Aktiengesellschaft). British Patent 927,669. May 29, 1963. Priority date Mar. 17, 1961, Switzerland.

A circulating system for the coolant of a gas-cooled nuclear reactor is patented. The system consists of a number of rotors having turbine blading and compressor blading, the compressor blading compressing the gas entering the reactor and the turbine blading expanding the heated gas coming from the reactor. Two like rotors are coaxially connected together so that each one is acted upon by part of the cooling gas in parallel directions. The directions of flow of the partial currents of the cooling gas to be expanded and those to be compressed are opposite to one another. This overcomes the disadvantage of the very high axial thrust that occurs when the turbine and compressor bladings act in the same direction. (M.P.G.)

**29752** DEVICE FOR MEASURING FISSION PRODUCTS IN A GAS PHASE AND ADAPTED FOR BURST SLUG DETECTION. (to Commissariat à l'Énergie Atomique). French Patent 1,266,614. June 5, 1961. Filed June 2, 1960.

In order to detect burst slugs, the ions formed by daughter products of gaseous fission products are electrostatically precipitated before they are brought to a radiation detection device. According to this patent, a cylindrical precipitation chamber is provided whereby the repulsion electrode is formed by the cylinder wall and an insulated piston is adapted to slide inside said cylinder supporting at its front face an electrode onto which said daughter products are precipitated. The cylinder is closed by the fronts of a scintillation counter and said piston, respectively, forming between them the precipitation chamber through which said gaseous phase flows. After a precipitation period, the piston with its electrode is brought into contact with the scintillation counter. (NPO)

**29753** AUTOMATIC COUPLING. (to Nuclear Power Plant Co., Ltd. and AGIP Nucleare). French Patent 1,268,066. June 19, 1961. Priority date Sept. 1, 1959, Great Britain.

In order to close an access channel of a reactor pressure vessel in a tight manner and to place a shielding plug therein, coupling means are provided to lock a sleeve into the top piece of the vertical access channel. This sleeve supports at its lower end the shielding plug. The sleeve is adapted to slide with piston rings in a boring of the top piece and is provided with locking elements which are adapted to move in directions having radial components in order to engage into cavities provided in the boring of the top piece. After placing the sleeve, some of the locking elements are brought into locking position by wedge-shaped push rods mutually connected via a ring shaped member sliding on the body of the sleeve. In case the pressure in the vessel increases, the sleeve pushes via a conical shoulder on the locking elements which are suitably constituted of steel ball in order to bring them into locking position, so that it is impossible to unlock the sleeve as long as the vessel is under pressure. (NPO)

**29754** DEVICE PLACED IN A PRESSURE RESISTANT CONTAINER OF A NUCLEAR REACTOR AND SERVING FOR THE REDUCTION OF VAPOR PRESSURE DEVELOPED DUE TO A BURST IN THE PRIMARY CIRCUIT. (to Licentia Patent Verwaltungs GmbH). French Patent 1,273,532. Sept. 4, 1961. Priority date Nov. 24, 1959, Germany.

In a pressure-resistant container which encloses the reactor pressure vessel, the biological shielding and the primary circuit, a device is provided for the reduction of the vapor pressure developed due to a burst in the primary circuit. This device comprises spaces filled with cold water through which is led at least a portion of the developed vapor. Suitably said container is divided by a horizontal wall into a lower compartment comprising the reactor and the primary circuit and an upper compartment in which cold water forms a pool with a free surface. This dividing wall has a plurality of apertures closed in such a manner that they open only when a relatively high compression arises in the lower compartment. Preferably the reactor installation has an auxiliary condenser, the cooling coils of which are placed in said water pool. (NPO)

**29755** CHARGING MACHINE FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,274,245. Sept. 11, 1961. Priority date Nov. 26, 1959, Great Britain.

A charging machine movable along the charging face of a nuclear reactor is adapted to be coupled with one of the charging channels connecting the charging face with the reactor core. The charging machine is provided with a remote viewing device for the visual control of the charging channel. This viewing device comprises an optical sighting element movable between two positions. In its working position it is introduced into the charging path of the nozzle connecting the machine with the channel, while in a second position it is withdrawn re-establishing in this manner a free passage through said nozzle. Light emerging from the channel is captured by said sighting element and is led via a light guide to an outside observation stand. (NPO)

**29756** FLUID TIGHT COUPLINGS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,279,130. Nov. 6, 1961. Priority date Feb. 10, 1960, Great Britain.

A fluid-tight coupling is provided between the charging machine of a nuclear reactor and the end of a reactor channel. For coupling, the machine is brought into a position so that its extensible charging nozzle is in alignment with the reactor channel in question. This reactor channel has at its end stepped cylindrical inner surfaces into which fits the nozzle end piece having also stepped cylindrical inner surfaces. In the coupled state, inner joining surfaces of the channel and of the nozzle end piece lie on a common cylindrical surface. A tubular sleeve slides with two sets of piston rings in this common surface and in an inner cylindrical surface of the nozzle end piece. By increasing or decreasing the fluid pressure in the space between the two piston ring sets the sleeve is moved axially between a position in which it is withdrawn and a position in which one of said sets fits into the inner surface of the channel end. (NPO)

**29757** NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,281,779. Dec. 4, 1961. Priority date Mar. 3, 1960, Great Britain.

A nuclear reactor is often provided with pressure tubes which pass through the reactor core and enclose the fuel elements with the circulating reactor coolant. According to this patent these pressure tubes are slightly undulated in the direction of their lengths. Preferably the diametral amplitude of these undulations does not exceed double the wall thickness of the tube, while the period of the undulations is higher than 0.4 of the inner diameter. These measures are taken in order to obtain pressure tubes which are not too thick at a given coolant pressure. (NPO)

**29758** HANDLING DEVICE. (to U. S. Atomic Energy Commission). French Patent 1,282,499. Mar. 21, [1962]. Priority date Mar. 21, 1960, United States.

In order to handle fuel elements in vertical reactor channels, a gripping device is lowered into the channel to grip the handling head of a fuel element. The gripping device comprises two gripping elements pivotally mounted in the lower part of the main body of the device and acting as tongs on the handling head of the fuel element. The movement of the gripping elements is controlled by the axial displacement of a rod axially slidable within the main body. This displacement is performed due to an electrical coil-winding acting on the rod against the action of a spring. Means are provided to lock the rod automatically in each of its end positions, as there is a tension between the said main body and the cable on which the device is suspended, so that when the rod comes to rest on the handling head, this tension disappears, the rod is unlocked and the gripping elements close on the handling head. (NPO)

**29759** IMPROVEMENTS RELATING TO NUCLEAR REACTORS. (to C. A. Parsons & Co., Ltd.). French Patent 1,284,379. Jan. 2, 1962. Priority date Mar. 25, 1960, Great Britain.

In order to avoid escape of radiation via a channel pass-

ing through the biological shield of a nuclear reactor, this channel is divided into a main rectilinear channel passing through the main shield and an auxiliary channel passing through an auxiliary shield arranged at the outside of the main shield and at a certain distance from it. The axis of the auxiliary channel is not in alignment with the axis of the main channel, while a curved tube connects the corresponding extremities of the channels. In case these channels are utilized for passing measuring instruments through them, a supplementary channel in the auxiliary shield is in alignment with the main channel but has a much smaller cross section. A push rod which can be coupled to the measuring instrument passes through the smaller channel in order to control the movement of the measuring instrument within the main channel. The measuring instrument is connected via a cable, passing the main and auxiliary channels, to the outside of the reactor. (NPO)

**29760** VERTICAL SUPPORT DEVICE OF CONSTANT HEIGHT FOR CONTAINERS e.g. FOR NUCLEAR REACTORS. (to Commissariat à l'Énergie Atomique). French Patent 1,286,792. Jan. 29, 1962. Filed Jan. 25, 1961.

Containers working at high temperatures, e.g., containers for nuclear reactors, are supported by vertical support devices of constant height placed at the corners of a regular polygon centered in the container axis. Said devices support the container at its bottom via universal joints, so that the horizontal orientation of the support faces is always preserved, the universal joints being mounted on columns transmitting the charge to the bases of the devices. Each column comprises a series of coaxial tubes, the thermal expansions of which are different from each other. These tubes are connected together in such a manner that their expansions result in a zero total expansion of the column. The columns are allowed to bend so that they are adapted to follow the radial expansion of the container's bottom. (NPO)

**29761** IMPROVEMENTS RELATING TO HEAVY WATER REACTORS. (to Aktiebolaget Atomenergi). French Patent 1,289,098. Feb. 19, 1962. Priority date May 11, 1960, Sweden.

In a heavy water nuclear reactor, utilizing natural or slightly enriched fissile material as nuclear fuel and in which the water temperature is higher than 100°C and preferably higher than 200°C, while the fuel rods of a circular cross section have diameters preferably smaller than 20 mm, the fuel rods are disposed parallel or obliquely to the direction of the water flow passing through the reactor. Suitably these fuel rods are regularly distributed over the reactor core space and are in direct contact with the heavy water serving both as moderator and as coolant. The rods are spaced from each other so that the ratio of volume of water to volume of nuclear fuel is high, especially higher than 5 or still better, higher than 15. (NPO)

**29762** CONTROL DEVICE FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,289,107. Feb. 19, 1962. Priority date May 10, 1960, Great Britain.

A control device for emergency shut down of a nuclear reactor is placed inside a vertical reactor channel and comprises three chambers on top of each other. These chambers communicate via holes with the reactor channel space and form for the lower chambers rapid gas leakages and for the top chamber a slow gas leakage. In the event of a sudden reduction in gas pressure in the reactor channel, a flexible diaphragm separating the two uppermost chambers is deflected downwardly as the pressure in the uppermost chamber goes down slower than in the other chambers. This flexion of the diaphragm controls the opening of a valve normally closed and separating the middle chamber from the lowest one so that discrete neutron absorbing bodies, normally stored in this medium chamber, fall down into the lowest chamber, increasing the neutron absorbing capacity of the device and shutting down the reactor. (NPO)

**29763** MANIPULATOR FOR RE-CHARGING THE FUEL ELEMENTS IN A NUCLEAR REACTOR. (to Sulzer Frères SA). French Patent 1,289,964. Feb. 26, 1962. Priority date June 8, 1960, Switzerland.

A nuclear reactor is known in which a series of parallel fuel elements are connected at one of the reactor faces with coolant entrance and exit headers while they are adapted to be removed via the opposite reactor face. This patent relates to a manipulator adapted to connect and disconnect the elements with respect to the coolant headers. The manipulator is mounted on a movable biological shield placed in front of the reactor face provided with the coolant header connections, so that the manipulator can be brought into alignment with a reactor channel. It comprises a set of concentric tubes showing protuberances fitting into slots of the different elements of the element coupling, so that rotations of the different tubes, controlled from outside the biological shield, can provoke rotations of the corresponding elements. In this way screw or bajonet couplings of the elements can be fastened or loosened. (NPO)

**29764** STEAM GENERATING SYSTEM. (to United Kingdom Atomic Energy Authority). French Patent 1,290,703. Mar. 5, 1962. Priority date June 1, 1960, Great Britain.

A steam generator is designed which is heated by an organic cooling liquid circulating through a nuclear reactor and provided with means for the removal of shut-down heat from the reactor when pumping power is not available to circulate the organic liquid. These means consist in placing the steam generator at a higher level than the reactor core, so that a convection flow of reactor coolant can be maintained. The steam generator is supplied with water and feeds steam to a steam drum disposed in such a way that a convection flow of water through the steam generator can be maintained. A circuit is provided for removal of steam from the drum, so that steam can be moved by convection flow through a heat sink and return as water to the drum. (NPO)

**29765** IMPROVEMENTS RELATING TO NUCLEAR REACTORS. (to Babcock & Wilcox Ltd.). French Patent 1,292,528. Mar. 26, 1962. Priority date June 15, 1960, Great Britain.

In a pressure tube reactor, the pressure tubes are generally made of a material having a low neutron absorption cross section and are connected to steel entrance or exit headers for the coolant. These connections pass steel nozzles forming a unity with the corresponding header. Each nozzle branches out at its end into two concentric tubular pieces forming between them an annular space into which is locked the end of the reactor pressure tube. This locking is performed by providing grooves in at least one of the inner surfaces of the annular space and in increasing the diameter of the inner tubular piece by the action of a mandrel, so that the material of the pressure tube, e.g., zirconium, is deformed and occupies finally the whole space between the concentric tubes of the steel nozzle. (NPO)

**29766** GATE FOR SHIELDING THE BEAM TUBE OF A NUCLEAR REACTOR. B. Frederick Coole (to A.E.I.-John Thompson Nuclear Energy Co., Ltd.). German

Patent 1,146,208. [Mar. 28, 1963]. Priority date July 9, 1959, Great Britain.

The gate described is for shielding beam tubes in nuclear reactors having a fluid medium for coolant. This gate is located in the face of such a tube and it can be moved horizontally by rolling it on wheels. The gate is provided with a shielding plate, e.g. of lead, which is attached to the gate by a rod system in such a way that it can be moved relative to the gate. As long as the gate is in a position at a distance from the tube, the plate is pressed against the gate by a spring within the gate, but when it is moved horizontally in front of the tube face, the movable plate is pressed against the tube by arresting its horizontal movement before the movement of the gate comes to rest. As the gate itself is forced further on in its movement, the rod system augments the distance between the gate and the plate. The movement of the gate ceases when the tube is hermetically sealed. (Gmelin Inst.)

**29767** CHARGING MACHINE FOR NUCLEAR REACTORS. K. Th. Peers, J. H. Jenkins, and P. Th. Hillyard (to Babcock & Wilcox Ltd.). German Patent 1,147,329. Apr. 18, 1963. Priority date Apr. 14, 1960, Great Britain.

A machine for loading and unloading gas-cooled nuclear reactors is described, which features an inner and an outer magazine arranged concentrically relative to each other. These two magazines are rotatable independent of each other and are located within a common pressure vessel. While the outer magazine is for storing both new and burned-up fuel elements, the inner magazine is provided with the devices necessary for the loading and unloading procedure. With this machine the loading and unloading operations are performed without any need for displacement of the whole machine. (Gmelin Inst.)

**29768** FUEL ELEMENT CHARGING APPARATUS FOR NUCLEAR REACTORS. John Antony Collis-Smith, Joseph Ralph, and Reginal William Creear (to English Electric Co., Ltd.). German Patent 1,148,337. May 9, 1963. Priority date June 4, 1959, Great Britain.

The charging apparatus described comprises an outer tube, a longitudinal aperture in the lower end of the tube, and a tubular duct extending within the outer tube. The lower end of the tubular duct can be displaced radially out from within the outer tube through the aperture in a required radial direction to be aligned with a selected fuel element channel. The lateral movement of the inner tubular duct through the aperture is achieved automatically by rotating the whole charging apparatus. A detailed description of the mechanical means for rotating the apparatus is given. (Gmelin Inst.)

**29769** DECAY HEAT COOLING SYSTEM. Winfried Eming and Heinz Franke (to Deutsche Babcock & Wilcox-Dampfkesselwerke). German Patent 1,148,664. May 16, 1963. Filed Nov. 7, 1961.

A separate decay heat cooling system is provided for dealing with the decay heat after reactor shut-down. The decay heat cooling system consists of a shell and tube heat exchanger in which two separate pump systems are located to circulate the primary coolant gas. One of these pump systems is arranged so as to be operated at the normal high gas pressure while the other one is put into operation if in the event of a primary system leakage the gas pressure gets very low. (Gmelin Inst.)

**29770** FLOODING DEVICE FOR THE SAFETY VESSEL OF A NUCLEAR REACTOR ABOARD A SHIP. Gerhard Woisin (to Gesellschaft fllr Kernenergieverwertung in Schiffbau und Schiffahrt mbH). German Patent 1,148,665. May 16, 1963. Filed Nov. 2, 1961.

The flooding device described for the safety vessel of a nuclear reactor aboard a ship contains flooding valves which are opened automatically at a predetermined pressure difference between the exterior of the ship, e.g., the surrounding sea water, and the inside of the safety vessel and are closed again after pressure equilibrium is attained. As the nuclear reactor is provided with a separate decay heat removal system which comprises a heat exchanger within the safety vessel and conduits for ventilating air from outside the ship through the heat exchanger, it is proposed to locate the flooding valves within the safety vessel in the walls of the conduits. Upon occurrence of damage to the ship, the conduits would facilitate the flooding of the safety vessel. As it is possible to locate the flooding valves both before and after the heat exchanger, only the flow resistance of conventional conduit elements must be considered. (Gmelin Inst.)

**29771** SEMIDIRECT EQUIPMENT MAINTENANCE. John R. Huston, William A. Webb, Robert G. McGrath, and Woodrow E. Johnson (to Westinghouse Electric Corp.). U. S. Patent 3,090,740. May 21, 1963. Filed May 14, 1957.

A means for semidirectly maintaining the system components, and especially the circulating pump, of the primary coolant loop in a homogeneous reactor is patented. The means includes a portable shield, which permits limited access of maintenance personnel to the primary loop components. The shield is particularly adapted for use with a canned motor-pump unit, where some of the biological shielding is provided by the structural components of the motor-pump. The design of the portable shield and the parts of the pump that pertain to shielding are described in detail. (M.P.G.)

**29772** MANIPULATING MACHINES FOR NUCLEAR REACTORS. Sydney Fawcett (to United Kingdom Atomic Energy Authority). U. S. Patent 3,090,741. May 21, 1963. Priority date June 24, 1957, Great Britain.

A machine for discharging fuel elements from the core of a nuclear reactor is patented. The device is of massive construction and forms part of the $\gamma$-ray shielding of the reactor. The machine consists of a fuel-element-storage chamber, a means for withdrawing a fuel element from the reactor and retaining it in the chamber, and a means for circulating a heat-transfer medium over a fuel element in the chamber and dissipating the heat generated by the fuel element. Details of the design are described and illustrated. (M.P.G.)

**29773** TEMPERATURE CONTROL MEANS FOR NUCLEAR REACTORS. Sydney Fawcett (to United Kingdom Atomic Energy Authority). U. S. Patent 3,090,742. May 21, 1963. Priority date June 27, 1958, Great Britain.

A method for preventing the reactivity of a gas-cooled graphite-moderated reactor from increasing with increasing temperature is patented. The coolant is divided into a fuel-element fraction and a moderator fraction, and a method for adjusting the relative sizes of the two fractions is provided. The coolant flow can be regulated by apertures, which expand or contract with temperature, or by temperature-sensitive valves. (M.P.G.)

**29774** NUCLEAR REACTOR DUCT STRUCTURE. Lucien Alfille (to Commissariat a l'Energie Atomique). U. S. Patent 3,090,743. May 21, 1963. Filed Apr. 15, 1960.

A guide tube for fuel elements in a heterogeneous

nuclear reactor is patented. The tube is constructed of monobloc vitreous silica and has a smooth interior surface. Means for absorbing variations in transverse and longitudinal dimensions of the tube are provided. The advantages of using vitreous silica and the structure of the guide tubes and adjacent tubes are described in detail. (M.P.G.)

**29775** NUCLEAR REACTOR SYSTEMS. Norman Bradley (to United Kingdom Atomic Energy Authority). U. S. Patent 3,091,582. May 28, 1963. Priority date Oct. 28, 1958, Great Britain.

A steam-cooled nuclear reactor installation is patented. The coolant fluid is converted from a liquid to a saturated vapor state by heat exchange in evaporators, and from a saturated vapor state to a superheated state by nuclear heat. Some of the superheated fluid is utilized to produce mechanical energy, and some is used in the evaporators to produce the saturated vapor. The circulation of the fluid is achieved without mechanical pumping in the vapor state. The reactor is moderated with heavy water and fueled with $UO_2$. The entire system is described in detail. Diagrams and design data are included. (M.P.G.)

**29776** NUCLEAR REACTOR FUEL ELEMENT AND METHOD FOR PRODUCING SUCH FUEL ELEMENT. Chapman J. Walker (to General Electric Co.). U. S. Patent 3,097,152. July 9, 1963. Filed Dec. 1, 1958.

Fuel elements with improved heat transfer properties are produced by sandwiching a layer of metal containing small elongated cells for the fuel material between two layers of cladding metal that are stressed to resist internal gas pressures. High fuel temperatures are avoided since heat from the fuel cell can pass parallel to the element surface into the central ply and then proceed perpendicularly to the element surface. The metal surrounding the fuel cells is all of higher conductivity than the fuel. (D.C.W.)

## Power Reactors

**29777** (ACNP-63016) PATHFINDER ATOMIC POWER PLANT. Technical Progress Report, January–March 1963. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). June 15, 1963. For Northern States Power Co., Minneapolis and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 46p.

Progress made in the development of the Sioux Falls Power Reactor is reported. Information is presented on stainless steel corrosion in oxygenated steam, development of low-enrichment superheater fuel elements, nuclear analysis of first-core boron–stainless steel poison shims and transient simulator, and testing and stability of oscillator rod assembly and in-core ion chambers. (N.W.R.)

**29778** (AECL-1741) PROGRESS AT DOUGLAS POINT. (Atomic Energy of Canada Ltd., Chalk River, Ont.). [1963]. 4p.

Developments in the construction of the Douglas Point Nuclear Power Station and in the fabrication of equipment and fuel for the facility are briefly described. Some description of the facility is included. (D.C.W.)

**29779** (DLCS-1470108) DETERMINATION OF REACTOR COOLANT SYSTEM PRESSURE DROP. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First issue, Apr. 15, 1963. Contract AT(11-1)-292. 14p.

This test is performed periodically to determine the reactor coolant system pressure drop and flow characteristics. The results of the test performed following the Seed 3–Seed 4 refueling are discussed. A slight decrease in performance figures was observed using the data obtained from the data acquisition system. This decrease is largely eliminated, however, if calculations are based on data obtained from the corresponding Norwood receiver-indicators, in which case the performance figures compare favorably with past performances of the test. (auth)

**29780** (DLCS-3360304) PERIODIC CALIBRATION OF PRESSURE INSTRUMENTATION. CORE 1, SEED 3. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First Issue, Apr. 26, 1963. 9p. Contract AT(11-1)-292.

The pressure instrumentation at the Shippingport Atomic Power Station which is associated with the reactor coolant system and the pressurizing and pressure relief system is calibrated periodically to determine and correct any calibration drift. The instrumentation was calibrated successfully during Core 1–Seed 3 lifetime. Any detectable calibration drift for this instrumentation was negligible. (auth)

**29781** (DLCS-3370104) PERIODIC CALIBRATION OF REACTOR PLANT FLOW INSTRUMENTATION. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First issue, Apr. 26, 1963. Contract AT(11-1)-292. 13p.

A test was carried out to determine and correct any drift in the calibration of the reactor coolant loop flow and the purification loop flow instrument trains and to scale the data acquisition system for these flows. None of the calibrations for either the receiver-indicators or the data acquisition system met the accuracy requirements specified in the approved test procedure; however, they were within accuracy specifications in the operating ranges. A comparison was made between the "as left" data from the fourth performance of this test and the "as found" data from the fifth performance. Except for the 1A reactor coolant loop flow, there was no discernible drift in any of the instrument trains. (auth)

**29782** (DLCS-3420105) PERIODIC CALIBRATION OF REACTOR PLANT DIFFERENTIAL PRESSURE INSTRUMENTATION. CORE 1, SEED 3. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First issue, Apr. 26, 1963. 11p. Contract AT(11-1)-292.

The reactor plant differential pressure instrumentation at the Shippingport Atomic Power Station is periodically calibrated to determine and correct calibration drift. In addition, the electrical zero of this instrumentation is checked occasionally to determine if it has changed since the previous calibration and to correct the instrumentation (if necessary) for this change. With few exceptions, the calibration drift for the differential pressure instrumentation was negligible during Core 1, Seed 3 lifetime. The various electrical zero checks and calibrations that were made concerning this instrumentation during Core 1, Seed 3 lifetime are described and the results of the checks and calibrations are discussed. (auth)

**29783** (DLCS-3430104) PERIODIC CALIBRATION OF LEVEL INSTRUMENTATION. CORE 1, SEED 3. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First issue, Apr. 26, 1963. Contract AT(11-1)-292. 9p.

The pressurizer level instrumentation at the Shippingport Atomic Power Station is calibrated periodically to determine and correct any drift. The instrumentation was calibrated satisfactorily during Core 1, Seed 3 lifetime. The data obtained during Core 1, Seed 3 calibrations indicated that the instrument drift was negligible. (auth)

**29784** (DLCS-3970101) RADIATION DOSAGE CONTROL DURING THE SEED 2–SEED 3 REFUELING. E. L. Murri, J. V. McColligan, and W. F. Wirth (Duquesne Light

Co., Shippingport, Penna.). First issue, Oct. 23, 1962. Second issue, Apr. 19, 1963. Contract AT(11-1)-292. 16p.

The radiation dose experience during Core 1, Seed 2 – Seed 3 refueling is summarized. The radiation control methods employed are outlined. Dosages are shown in graph form. The total dose received by personnel engaged directly in the refueling work was 180 rem. (M.C.G.)

**29785** (DLCS-5000563) MONTHLY OPERATING REPORT, MAY 1963. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 43p.

The Shippingport Atomic Power Station operated throughout May 1963 in accordance with the requirements of HDS and operational testing, maintenance, and system capacity. An electrical ground was detected in the rod control system which necessitated a station shutdown for investigation and subsequent repair of the reactor vessel fuel port seal weld H-7. Rod control stator No. 81 failed during a precritical check for rod latching. The gas-stripper vacuum-pump-seal water cooler was effectively cleaned by chemical treatment. Conditions related to radioactive contamination were normal. Three tests were completed and 5 were still in progress. (M.C.G.)

**29786** (GA-3396) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1962. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-314. 61p.

Research and development progress specifically directed toward the construction of a 40-Mw(e) prototype power plant employing a high-temperature, gas-cooled, graphite-moderated reactor known as the HTGR is reported. Irradiation of element III-B in the in-pile loop continued satisfactorily. The element has generated a total of 136.3 Mw-hr of fission heat. The gross activity in the purge stream increased slightly to about 350 $\mu C/cm^3$. By taking larger gas samples than were previously taken, a value of 0.02 $\mu C/cm^3$ was obtained for the gross activity of the primary loop. Element III-A, which was removed from the loop after generating 133 Mw-hr of fission heat, was disassembled and examined. No fuel-compact damage of any type was visible. Determination of the distribution of fission products in the element is under way. Fission-product-release data for in-pile-loop element III-A were calculated. During the 133 Mw-hr of operation, the release fraction increased by approximately one order of magnitude. Also calculated were the xenon and krypton release data for the first 100 Mw-hr of III-B operation. The release rate for the longer-lived isotopes increased by about a factor of 10 and that of the shorter-lived isotopes by about a factor of 100. A test was run in which the in-pile-loop purge flow was stopped. The primary-loop activity level rose sharply during the first hour, increased at a slower rate for the next 11 hr, and then appeared to level off. When purge flow was resumed, the gross activity in the primary loop was cleaned up with a half life of about 2.2 hr. An attempt was made to identify $Cs^{137}$ and $Ba^{140}$ plateout in portions of the in-pile loop. A very small amount of cesium (less than a monolayer) was found, but no barium could be detected. The validity of two basic assumptions made in the one-dimensional burnup code FEVER was investigated. As a result of extensive lifetime studies and power-distribution and temperature-coefficient calculations, the initial fuel loading for the Peach Bottom core was specified. A series of control-rod-worth calculations and a recalculation of the postulated rod-fall accident were made for this loading. The test of the prototype control rod and drive was satisfactorily completed during the quarter. During the course of the test the drive completed 590,641 starts and stops, 5,756 scrams, and more than 2.6 million inches of random regulating motion in helium at reactor temperatures. These totals far exceed the expected life requirements of the system. Preparations are being made for testing the prototype emergency shutdown rod and drive. The apparatus for the barium permeation experiment with a full-diameter sleeve was completed, and preliminary calibration runs were started. Following these runs, the system will be operated until an equilibrium distribution of barium is reached. At that time, a series of corings will be made on all of the compacts and the sleeve to evaluate the overall barium and strontium distribution. Other experiments on barium behavior, including permeation experiments with reduced-scale fuel elements and experiments on the vaporization, sorption, and diffusion of barium, were continued, and the data are being analyzed. Measurements were made to compare the room-temperature back diffusion of argon, krypton, and xenon through a sample of sleeve graphite against a helium pressure difference. The results show that the difference between the effective back-diffusion coefficients of krypton and xenon seems to increase with increasing helium pressure difference across the sleeve. The argon and krypton back-diffusion data at an average pressure of 3 atm are essentially the same. A FORTRAN code was written to recalculate the retention of neutron poison material and fission products in the core as well as their condensation on and revaporization from the upper reflector following a complete loss-of-coolant-circulation accident. (auth)

**29787** (GAMD-2605(Rev.2)) PRIMARY COOLANT SYSTEM BLOWDOWN ACCIDENT FOR PEACH BOTTOM HTGR. J. A. Landoni and M. L. Skinner (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Dec. 15, 1962. Contract AT(04-3)-314. 125p.

An investigation is made of helium depressurization in the Peach Bottom HTGR following large ruptures in the primary coolant system. Ruptures of a non-concentric duct near the steam generator and near the reactor vessel, as well as ruptures of the refueling nozzles in the top head of the reactor vessel, are assumed. Two different sizes of rupture openings are assumed at each location. Calculations are performed with a Fortran code for the IBM 7090. The equations, Fortran program logic, Fortran listing, and sample computer printout are included. The results indicate that none of the ruptures investigated should cause permanent loss of flow (due to compressor damage) in both main coolant loops, or cause damage to both steam generators. Therefore, at least one compressor and its associated steam generator can always be available for post-rupture forced-circulation cooling of the reactor. The complete shear and instantaneous removal of one of the largest fuel handling nozzles and plugs in the reactor vessel head is the only case that might lead to core lifting. The maximum height of core lifting is about 0.8 in. As a large concrete missile shield is located above the refueling nozzles, and prevents the nozzles and plugs from moving more than a fraction of an inch, the large opening assumed is impossible to attain. Therefore, levitation is considered an "incredible" accident. (auth)

**29788** (GAMD-3269) TEMPERATURE DISTRIBUTION IN EBOR FUEL RODS DUE TO NON-UNIFORM CIRCUMFERENTIAL COOLING. R. Katz (General Atomic Div. General Dynamics Corp., San Diego, Calif.). June 29, 1962. Contract AT(04-3)-187. 30p.

An analysis is made of the temperature distribution in an EBOR fuel rod resulting from non-uniform circumferential cooling. The cooling is not uniform about the periphery of a fuel rod because of the non-uniform coolant flow distribution dictated by the geometrical arrangement of the fuel rods in the EBOR element. The investigation is concerned primarily with the fuel cladding, because this component is limiting from the standpoint of temperature in the core. The effect on the maximum circumferential temperature distribution in the fuel cladding of variations in the governing parameters is investigated. The temperature distribution in the fuel cladding is computed for the EBOR design point based upon an experimentally determined heat transfer coefficient. The maximum circumferential variation of the heat transfer coefficient is about 25%, and this amounts to a maximum temperature variation of about 13°F in the fuel cladding. The problem investigated for EBOR is common to all reactors employing fuel rods. The present analysis may be applied directly to any fuel rod similar to the EBOR type—that is, a solid cylindrical rod with internal heat generation surrounded by a closely fitting sheath—and for any given heat transfer coefficient distributions at the outer radius. The analysis may also be easily extended to other cylindrical shapes and for other boundary conditions. (auth)

**29789** (GEAP-3932) PHYSICS CALCULATIONS FOR THE CONSUMERS BIG ROCK POINT PROCESS COMPUTER. N. H. Barth (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). May 1963. Contract AT(04-3)-361. 46p.

The physics calculations to be performed on the Consumers On-Line Process Computer are reported. As a result of these calculations, a three-dimensional power shape is simulated, a reactivity balance is approximated, and the neutron exposures of each third of each fuel bundle and control rod are accumulated. (auth)

**29790** (GEAP-4083) DEVELOPMENT OF PULSED NEUTRON APPLICATION TO POWER REACTOR START-UP PROCEDURES. Second Quarterly Progress Report, July 1—September 30, 1962. Paul Meyer and Edward Garelis (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 1, 1962. Contract AT(04-3)-189. 12p.

A technique is being developed to use pulsed neutron sources to measure the shutdown of large, thermal power reactors. A theoretical investigation to identify an experimental observable was conducted. A neutron detection system is being developed to be used in the presence of a very intense gamma activity. Electronic accessories are being designed and constructed for the operation of a pulsed neutron source tube of high yield. (M.C.G.)

**29791** (GEAP-4218) DEVELOPMENT PROGRAM FOR INCREASED OUTPUT IN THE GARIGLIANO NUCLEAR REACTOR. Quarterly Report No. 2. E. P. Quinn (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 1, 1963. Work performed under United States—Euratom Joint Research and Development Program. Contract AT(04-3)-189. 26p. (EURAEC-643)

Two development programs are discussed: the preparation of test specimens of reactor vessel material for irradiation and the formulation of specifications for a complete data logging and computer system. (N.W.R.)

**29792** (JAERI-1044) DERIVATION OF TRANSFER FUNCTIONS OF NATURAL CIRCULATION BOILING WATER REACTOR. Junichi Miida and Nobuhide Suda (Japan Atomic Energy Research Inst., Tokyo). 1963. 27p.

The dynamic behavior of a natural circulation boiling water reactor is complicated because it includes the dynamics of the void generation in the core and the hydrodynamic considerations in connection with the determination of the recirculation flow. The transfer functions are obtained under several basic assumptions. Efforts are made to cover all the important features of the boiling water reactor dynamics and also to avoid too complex expressions to simulate on an analog computer. The basic assumptions used are: the distribution of the parameters in the axial direction of the core is taken into account, while the change in radial direction is ignored; the distribution of heat flux along the channel is considered uniform; and the slip between the steam and the water is ignored. (auth)

**29793** (LAMS-2904) TEST CELL—A SHIELDING STUDY. KIWI B-4A. P. K. Lee, F. M. Cox, and W. H. Schweitzer (Los Alamos Scientific Lab., N. Mex.). Mar. 1963. Contract W-7405-eng-36. 27p.

Gamma doses produced by the Kiwi B-4A reactor test were measured at 49 stations in the Test Cell A Area. Most of the stations were located in permanent structures or at locations at which structures served as shadow shields. The study was conducted to determine the reduction in gamma doses caused by the shielding structures. It was found that the gamma doses in the test cell were reduced by factors ranging from $3 \times 10^{-4}$ to $3 \times 10^{-3}$, and the dose reductions for the J-8 Bunker and the test cell access tunnel were of the order of $2 \times 10^{-3}$ and $2 \times 10^{-4}$, respectively. Doses were reduced at positions in which the test cell served as shadow shield by factors ranging from $10^{-1}$ to $5 \times 10^{-2}$. (auth)

**29794** (MITNE-28) THE EFFECTS OF CHANGING ECONOMIC CONDITIONS ON FUEL CYCLE COSTS IN PRESSURIZED WATER REACTORS. Manson Benedict, Henri Fenech, and Max C. Richardson (Massachusetts Inst. of Tech., Cambridge). Feb. 1, 1963. For East Central Nuclear Group, Inc. 53p.

The effects of changing economic conditions on fuel cycle costs in an advanced pressurized-water power reactor with free-standing stainless steel or Zircaloy fuel cladding are analyzed for eight different cost bases. These cost bases represent the effect of most of the combinations of economic conditions likely to occur during the life of the 461 Mw(e) reactor. The cost bases are dependent on the following economic parameters: cost of natural uranium hexafluoride, weight fraction of uranium-235 in uranium hexafluoride of zero value, cost of separative work, fabrication cost of stainless steel and Zircaloy-4 fuels, $Pu(NO_3)_4$ to plutonium cost, plutonium credit, uranium hexafluoride carrying charge excluding time of fabrication, uranium hexafluoride carrying charge during time of fabrication, carrying charge on fabrication cost, and uranium hexafluoride loss during fabrication of stainless steel and Zircaloy-4 fuels. Three methods of fueling are also considered: batch, and three- or five-zone "outing." (N.W.R.)

**29795** (NAA-SR-8401) HALLAM NUCLEAR POWER FACILITY—REACTOR OPERATIONS ANALYSIS PROGRAM. Semiannual Progress Report No. 1, September 1, 1962 through February 28, 1963. O. J. Foust, C. L. Larson, R. M. Mills, D. I. Monnie, R. J. Walters, O. G. Jenkins, Jr., and R. R. Stiens (Atomics International. Div. of North American Aviation, Inc., Canoga Park, California). July 1, 1963. Contract AT(11-1)-Gen-8. 151p.

The HNPF has operated to 15% full power (38 Mwt) and

performs satisfactorily in every respect. During this testing period, operations evaluation is accomplished by site personnel as a part of the startup and testing activities; ROAP personnel utilize this time mainly to develop analytical methods to be used for subsequent operations analysis. When startup testing is completed, ROAP personnel will analyze operating data and act in a technical consulting capacity. Output data from the reactor will be used as input to a digital computer which will calculate various quantities including predicted and measured reactivity. The difference between the measured reactivity, which is a function of control rod position, and predicted reactivity will be used on a continuing basis to analyze core normalcy. Records will be maintained on individual control rod exposure, calculated and measured rod burnup, at-power calibrations, and rod performance. A fuel management program will be maintained, including fuel burnup records and fuel destructive examination analyses. The chief object of this portion of ROAP is to achieve the highest fuel exposure consistent with economical, safe, and practical plant operation. Axial and radial flux distributions and other core conditions will be analyzed by comparing in-core temperatures during normal plant operation with initial temperatures taken under known core conditions. Performance of the main heat transfer system and its components will be analyzed as a function of time. In analyzing the sodium service system, records will be maintained and evaluated on sodium purity and components performance. A components reliability program will be maintained consisting mainly of equipment history records. From this information, detailed reliability studies and miscellaneous performance analyses will be made. (auth)

**29796** (NAA-SR-Memo-8407) PREIRRADIATION MEASUREMENTS OF PIQUA FUEL ELEMENTS P-1097, P-1098, P-1099, P-1100, AND P-1117. B. F. DaSilva and H. J. Hubbell (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 31, 1963. Contract AT-11-1-GEN-8. 89p.

The inspection and test data collected in assuring that Piqua fuel cylinders met the design requirements are assembled. A description of the techniques and equipment used in obtaining the data is also included. (auth)

**29797** (NAA-SR-Memo-8485) RESONANT VIBRATION OF HALLAM NUCLEAR POWER FACILITY SODIUM PUMPS. F. J. Waters (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 15, 1963. Contract AT-11-1-GEN-8. 8p.

An analysis is made to explain the cause and origin of the resonant vibrations of the Hallam Nuclear Power Facility Sodium Pumps. The results are compared with measured values. The correlation with experimental results shows the causes of the vibration are: the even number of vanes existing on pump impeller and diffuser sections and the mounting of the diffuser and impeller sections on a different horizontal centerline than the pump spherical case. Recommendations are made to eliminate the resonant frequency problem. (auth)

**29798** (NDL-TR-47) A COMPILATION OF CAMP CENTURY ENVIRONMENTAL MONITORING DATA FROM 30 JUNE 1961 TO 27 JUNE 1962. D. T. Kilminster, E. M. Hayes, U. I. Ievans, and J. H. McNeilly (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Mar. 1963. 28p.

The results of weeks 59 through 110 of the Environmental Monitoring Program for the Army Package Power Reactor located at Camp Century, Greenland are presented. Alpha and beta activities of snow, water, and air samples are reported. Gamma survey readings of the sampling stations are also included. All observed sample activities were below the maximum permissible concentrations recommended by the Atomic Energy Commission. (auth)

**29799** (ORNL-TM-609) PRODUCTION OF FERTILIZER IN A MULTIPURPOSE ATOMIC POWER REACTOR COMPLEX FOR DISTILLATION OF SEA WATER: A SURVEY. R. E. Blanco (Oak Ridge National Lab., Tenn.). July 3, 1963. Contract [W-7405-eng-26]. 37p.

A survey was made to determine the feasibility of producing large amounts of nitrogen, phosphate, and potassium fertilizers with the cheap power produced from a large atomic reactor. The optimum combination was a multipurpose plant to produce fresh water from sea water by distillation and fertilizer from the air, sea, and phosphate rock. No other raw materials are required and only the three principal fertilizers containing nitrogen, phosphorus, and potassium are produced. Large amounts of byproducts, requiring shipment and sale, are not produced. The arc process is used for nitrogen fixation from air to produce nitric acid and fresh water is electrolyzed to produce hydrogen for nitrogen fixation from air as ammonia. Ammonium nitrate can be formed as the final product. Alternatively, nitric acid could be produced by oxidation of ammonia instead of the arc process, if cheaper. Dicalcium phosphate or triple superphosphates are produced by nitric acid leaching of phosphate rock or by treating phosphate rock in an electric furnace with coke and silica. In the furnace process, coke must be shipped in as a raw material but silica would be available at oceanside locations. Potassium is recovered from sea water by precipitation of potassium dipicrylamine. Acidification of the precipitate with nitric acid produces potassium nitrate and the dipicrylamine is freed for reuse. Potassium can also be precipitated as magnesium calcium potassium phosphate but additional caustic must be shipped in to neutralize the phosphoric acid. The effect of reducing power costs per kwh from 8 to 10 mills for private industry or from 4 mill/kwh for TVA to 1 mill at a large multipurpose reactor station were estimated. The use of electrical power to replace natural gas as a process heat source was also assumed. Reductions in ammonia or dicalcium phosphate prices of less than 5% were predicted since these processes use large amounts of natural gas as process heat which has a cost equivalent to 1 mill/kwh. Conversely, however, the use of 1 mill/kwh electrical power would permit production of economical fertilizer at locations where natural gas is unavailable or must be conserved. The reduction of power cost from 4 to 1 mill/kwh decreased the cost of triple superphosphate produced in electric furnaces by 13%. This cost was estimated to be 16% cheaper than for superphosphate produced by the conventional sulfuric acid process at a Florida location. The cost of producing ammonium nitrate, a very desirable solid form of fertilizer suitable for long distance shipment, was estimated. The cost, by the electrolysis of water (at 1 mill/kwh) to produce hydrogen, fixation of nitrogen and hydrogen as ammonia, and oxidation of ammonia to nitric acid route, was estimated to be about 50% higher than the present method which uses natural gas as a raw material to produce hydrogen. Since these steps are modern engineering techniques, little further reduction in cost is expected. Hence, the production of nitric acid by arc fixation of air is the key item which could potentially reduce costs significantly for the whole complex but one which could not be estimated with accuracy without a detailed cost estimate and design survey. At 1 mill/kwh, the power cost alone for arc fixation of nitrogen is $0.029/

lb N. Thus arc fixation nitrogen might be competitive with ammonium nitrate but not with ammonia which sell for $0.104 and $0.056/lb N, respectively. Since only 3% of the total energy of the arc process is used for nitrogen fixation, the wasted heat could be used to distill sea water and thus reduce the cost of nitrogen fixation. However, the reduction in cost of nitrogen fixation may be small since the energy is degraded before return to the distillation system. For example, if 30% of the heat is recovered as high temperature steam (worth $0.41 mill/kwh$_h$ or 120 mill/$10^6$ Btu) and 20% is useful as process heat (worth $0.034 mill/kwh$_h$ or 10 mill/$10^6$ Btu) the reduction in total cost of power for nitrogen fixation (using 1 mill/kwh$_e$) is 13%. Increasing the efficiency of the arc process (i.e., the yield of nitrogen/kwh$_e$) is considered the best means for decreasing the cost of nitric acid produced by the arc method. (auth)

**29800** (RT/FI(63)12) CALCOLI A MOLTI GRUPPI DI REATTORI A MODERATORE ORGANICO. (Multigroup Calculations for Organic Moderator Reactors). F. Casali, A. M. Melandri, F. Pierantoni (Italy. Comitato Nazionale per l'Energia Nuclear. Centro di Calcolo, Bologna). Mar. 1963. 26p.

Eighteen-group calculations were made for OMRE and PRO-P type reactors. Theoretical calculations for $K_{eff}$ of OMRE agreed to within 1% of the experimental value reported in the literature. (auth)

**29801** (SL-1998) SALINE WATER CONVERSION POWER REACTOR PLANTS. (Sargent and Lundy, Chicago). Jan. 11, 1963. For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26]; Subcontract [2086]. 201p.

Conceptual designs and construction cost estimates of two heavy-water-moderated, natural-uranium-fueled power reactor plants are reported. Both plants use vertical pressure tube reactors, in which heat is transferred to boiling light water, as heat sources. A part of the energy in the steam is converted to electrical energy in steam turbine-generators; the energy in the turbine exhaust steam is used to heat sea water in the turbine condensers. The sea water flows to an adjacent distillation plant for the production of fresh water. Two plant sizes are considered. One consists of a full-scale system designed to produce a power output of 25,000 thermal megawatts. The second system is based on a reactor having a thermal power output of 3,500 Mw(t) and is considered to be a prototype of the larger plant. A preliminary composite flow diagram of the 25,000 Mw plant is given. Three reactors, each designed for a heat power output of 8,333 Mw, are used to produce 600 psi saturated steam for nine turbine generators. The turbines exhaust to nine brine heater-surface condensers at exhaust conditions of 17.2 psia, 220°F; the heat of vaporization is removed in the sea water by heating it from 185 to 200°F. The plant outputs are about 4,000 Mw(e) to the switchyard and 20,300 Mw(t) as 200°F sea water. The study includes all facilities for a complete power generating system, including the switchyard, control rooms, waste disposal systems, offices and shops in addition to the structures and systems associated with the reactor-turbine complex. The general layout of the plant is shown. Each reactor is contained in a separate containment structure, and all nine turbine-generators are located in a single containment building. The reactor buildings consist of vertical pre-stressed concrete cylinders, capped with hemispherical domes, while the turbine containment building is one-half of a horizontal steel cylinder, capped on the ends with spherical quadrants. In cross section, the turbine building is semi-circular with a flat concrete floor. The reactor and turbine containment structures form one containment volume for the expansion of reactor coolant in the event of a coolant system rupture. Based on the complete loss of coolant from one reactor, the building design pressure is 8.5 psig. Both the reactor and turbine buildings have double outer shells, with the space between the shells connected to a waste gas compression system, allowing leakage from the inner shell to be collected, monitored, passed through iodine filters and disposed of safely. The study includes necessary electrical auxiliaries, heating, ventilating and air conditioning systems, and plant utilities such as fire protection systems, and sewage systems. It is assumed that the sea water for the brine heaters and that used for miscellaneous cooling purposes in the plant is pumped to the power plant by pumps at the saline water evaporation plant. Power for these pumps is transmitted to the saline water plant by three 345 kv feeders from the switchyard. Approximately 200 Mw(e) is estimated to be required for this service. The 3,500 Mw plant uses one pressure tube reactor to produce saturated steam at 600 psi. Two 325 Mw(e) turbine generators are driven by the steam, which condenses in brine heaters at 17.2 psia, 220°F before being pumped back to the reactor inlet as condensate. The heat of vaporization of the turbine exhaust steam is used to raise the temperature of the sea water from 185 to 200°F, as in the 25,000 Mw plant. This system generates a gross power output to the switchyard of 574 Mw(e). The output of 200°F sea water is about 2800 Mw(t) under these conditions. The plant structures differ from those of the 25,000 Mw plant, in that only the reactor systems are housed in a containment structure. The turbines are located on foundations that are outdoor structures, and the turbine-generators and auxiliaries are weatherproofed for outdoor service. The containment building for this plant has only a single containment barrier, and consists of a vertical cylindrical steel building 180 feet in diameter, enclosed at the top by a hemisphere and at the bottom by a hemiellipsoid. The design pressure of the containment building (18.5 psig) is based on instantaneous release of the entire reactor coolant inventory to the interior of the building. As provided for the 25,000 Mw plant, the 3,500 Mw system includes switchyard, control building, waste disposal systems, and offices and shops necessary for a complete power plant. It is assumed that pumping facilities for the sea water for condensing purposes and miscellaneous cooling services are provided at the evaporating plant. The estimated capital investments for the plants are $126,095,000 for the 3,500 Mw plant and $607,787,000 for the 25,000 Mw plant. (auth)

**29802** (TID-11597) HEAT TRANSFER EXPERIMENTS OF THE TITLE II FUEL ASSEMBLY FOR THE EXPERIMENTAL GAS COOLED REACTOR. SECTION IV OF THE FUEL ASSEMBLY HEAT TRANSFER AND CHANNEL PRESSURE DROP EXPERIMENT OF THE EGCR RESEARCH AND DEVELOPMENT PROGRAM. Report RD-0010. Thomas J. McDonald and R. M. Higgins (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Oct. 3, 1960. Contract AT(10-1)-925. 95p.

Experimental heat transfer data and analysis are reported for the Title II fuel assembly design modifications and refinements. Three distinct mid-length spacer designs are described. All tests are conducted with a 3.000-in. ID fuel assembly sleeve and with the six outer tubes (of the seven tube cluster) located on a 2.000-in. BC. The data are presented as heat transfer correlations and as comparisons of the heat transfer test results of one design with the results obtained from the other two and also the test results of the Title I fuel assembly design spacers. (auth)

**29803** (TID-11599) CORE SEAL EXPERIMENT [FOR] EGCR RESEARCH AND DEVELOPMENT SECTION. Report No. RD-0201. P. J. Lain (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Aug. 1, 1960. Revised June 2, 1961. For Kaiser Engineers. Div. of Henry J. Kaiser Co., Oakland, Calif. Contract AT(10-1)-925. 46p.

The core-seal experiment consists of an evaluation of gas leakage across the seal faces at the simulated junctions between the seal face and the graphite columns and between the seal face and core-support plate. The bellows seal was tested in air and helium. Results indicate that any arrangement cannot be duplicated once the specimen is disassembled and that the results vary considerably. (N.W.R.)

**29804** (TID-18975) HALLAM NUCLEAR POWER FACILITY— FUEL CYCLES. M. P. Aronchick (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 15, 1958. Revised Oct. 31, 1962. Contract [AT(04-3)-187]. 29p.

The Hallam Nuclear Power Facility Fuel Cycle is described. Detailed costs for each of the fuel-cycle processes were collected and, based on the available reactor design information, the overall fuel cycle costs were estimated. The reference fuel for the first core loading is an alloy of uranium and 10 wt % molybdenum. As this fuel is depleted and removed, it will be replaced by uranium carbide fuel. (M.C.G.)

**29805** (UCRL-7145) CONTROL OF THE BLOWDOWN AIR SUPPLY FOR THE TORY II-C NUCLEAR RAMJET ENGINE. R. B. Hollstien (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 1, 1963. Contract W-7405-eng-48. 97p.

An analysis of the blowdown air supply for the Tory II-C experimental nuclear ramjet engine was conducted with emphasis on characteristics important in the design of controls. The blowdown control for the Tory II-C operations was designed using an approximation of the process inverse in an open loop computer which was combined with corrective feedback loops to control the weight flow and temperature of air delivered to the reactor. A method of extending the control capability to include the simulation of reactor inlet conditions during the launch of nuclear powered missiles is described. The analysis, design, and description of the expected performance are based on an analog computer model of the blowdown system. (auth)

**29806** (AEC-tr-5887) OPERATION OF STEAM GENERATORS IN THE FIRST ATOMIC POWER PLANT. G. N. Ushakov, V. B. Lytkin, L. A. Kochetkov, V. V. Popov, N. T. Belinskaya, and A. F. Sokolov [Moscow State Univ.]. Translated by Lydia Venters (Argonne National Lab.) from IAEA Proceedings of the Conference on the Exploitation of Power Reactors, held in Vienna, June 1963. 15p.

The design of the steam generators of the first atomic power plant, methods of their control during construction, and the conditions of their operation are described. Damages to the steam generator tubes and possible causes of these troubles are discussed. (auth)

**29807** (TRG-Inf-Ser-314) DESIGN PRINCIPLES FOR GAS-COOLED SHIP REACTORS. D. Smidt. Translated by M. J. Watts (U.K.A.E.A. Reactor Group, Risley, Lancs, Eng.) from Atomkernenergie, 5: 361-6(1960). 15p.

The design principles of gas-cooled ship reactors are described. Heat transfer and neutron physics technology and choice of materials are explained. Reasons are given for some of the advantages of gas cooling, namely low shielding weight, simple construction and running, a cheap conventional secondary circuit, and good safety under normal and abnormal running conditions. Finally, some design data of a study already completed are presented. (auth)

**29808** NUCLEAR FUELS FOR POWER REACTORS. I. Mirion (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 13: 973-85 (1962). (In Rumanian)

The theoretical and practical requirements of power reactor fuels are reviewed critically. The factors considered include the nuclear properties necessary for a sustained chain reaction, such as the concentration of fissionable and neutron-absorbing elements in the material, the heat-transfer parameters, including heat conductivity and refractoriness, chemical stability and corrosion resistance, thermal shock resistance, and radiation resistance. The currently used or proposed fuels are reviewed and compared. Although liquid fuels are used only in experimental reactors, they are considered to be quite attractive because they allow high burnup, continuous elimination of fission products poisoning the system, and uninterrupted replenishment while acting simultaneously as the heat transfer agent; however, many technical problems remain yet to be solved. The solid fuels, including the pure metals, alloys, oxides, and dispersed cermet-type systems, are reviewed in detail. The properties of 21 reactor fuels are tabulated. It is pointed out that in view of the considerable amount of work currently in progress, it is not possible to predict what type of material will be ultimately adopted. The increased use of refractory materials becomes more and more pronounced. Complete burnup cycles are usually considered. (TTT)

**29809** THE CONSTRUCTION OF NUCLEAR POWER STATIONS IN PAKISTAN WITH THE PARTICIPATION OF THE GERMAN REACTOR INDUSTRY. H. J. Bruechner (AEG-Kernenergieanlagen, Frankfurt am Main), K. Alzinger, and W. Altvater. Atomwirtschaft, 8: 352-6(June 1963). (In German)

Early in 1962 a delegation of German nuclear power station experts visited Pakistan in order to examine the conditions for building a nuclear power station with German participation. It is stated in their report that the primary energy situation in Pakistan with its population of 95 million and area of 945 million $km^2$ is not favorable. Different conditions exist in West and in East Pakistan which are separated by 2,000 km. A 100 MW(e) atomic power station in Karachi was considered for West Pakistan but its ability to compete with a natural gas power station is not immediately obvious. Favorable prospects exist in East Pakistan for a 50 MW(e) atomic power station for which a site was scheduled in Rooppur. A comparison of the economics of a boiling water reactor with those of a competitive oil power station for this project showed results favorable for the former under certain conditions. Participation of the German reactor industry was recommended. (auth)

**29810** TECHNICAL QUESTIONS OF FUEL ELEMENT GUARANTEES. K. Peuster (Rheinisch-Westfälisches Elektrizitätswerk AG, Essen). Atomwirtschaft, 8: 366-70(June 1963). (In German)

One essential problem is that any guaranteed value only has technical significance if it is related to precisely defined conditions. A detailed examination is made in the case of water-moderated power reactors of the boundary conditions which are of importance in this connection. A

case for invoking a guarantee always presents itself if the element change plan for a reactor cannot be adhered to either because an unplanned opening of the reactor must be made or, in the case of a scheduled opening, more elements need changing than was foreseen. Grounds for this could be: element damage, insufficient core reactivity, increased hot spot factors, and control rod faults. There are theoretically several possibilities on the basis of the attained degree of burn-up for the reimbursement under a guarantee claim: separate guarantees against element damage and loss of reactivity, the same guarantee against element damage and loss of reactivity, and regular fuel service by the manufacturer. The measurement of the burn-up attained at the time represents a special problem in each case. The assessment of the burn-up of individual elements, which requires extensive calculations, is in every case an important clause of the guarantee agreements. The measures to be taken in the event of a claim depend on the kind of damage, the effects on the reactor operation, etc. In the case of element damage the release of fission products represents a ground for opening the reactor and changing the elements if the resulting activity appearing in the cooling medium exceeds the officially permitted value. When grounds for a claim arise direct and indirect damages exist for the reactor operator: the total costs of the fuel which cover manufacture, transport, insurance, reprocessing, interest payments etc., must be made good from a smaller energy production than anticipated; the necessary additional opening up of the reactor means, at present, almost inevitably a reactor shut-down. (auth)

**29811** THE ENRICO FERMI NUCLEAR POWER PLANT AT TRINO VERCELLESE. Comit. Nazl. Energia Nucl., Notiziario, 9: 47-77(June 1963). (In Italian)

The nuclear power plant under construction at Trino Vercellese is described in detail. The plant is powered with a PWR reactor and is scheduled to start operation in 1964. The plant sections discussed are the nuclear section (core, pressure vessel, fuel elements, control rods, and control rod drive mechanism), primary cooling circuit, auxiliary systems for the nuclear section (reactor control and monitoring, pressure control, volume control, corrosion control, purification system, removal of residual heat, chemical shut-down system, scram system, and fuel and control rod manipulation system), containment and biological shielding, and traditional features of a power plant. (J.S.R.)

**29812** A SURVEY OF WATER MODERATED POWER REACTORS DEVELOPED BY THE U.S.A. N. M. Harris. Nucl. Energy, 196-203(July 1963).

The history of the USAEC program for the development of nuclear power is outlined. The scope of the pressurized-water and boiling-water reactor programs and the reactors constructed in these programs are discussed in some detail. Reactors in other countries are also considered. The future USAEC program is discussed briefly. (D.L.C.)

**29813** NUCLEAR SHIP PROPULSION. H. F. Atkins. Nucl. Energy, 205-8(July 1963).

The reasons given by the AEA for the choice of the Vulcain and Integral Boiling Reactor designs are discussed and shown to be invalid. The weaknesses of the designs are considered in detail. (D.L.C.)

**29814** TERMODINAMICHESKIE TSIKLY ATOMNYKH ELEKTROSTANTSII. (Thermodynamic Cycles of Atomic Electric Power Plants). D. D. Kalafati. Moscow, State Publishing House of Power Engineering, 1963. 280p.

The operating conditions, economy, and criteria evaluation for the selection of thermal systems for an atomic electric power plant are discussed. Optimum cycle parameters, heat losses in the steam generator and condenser, heat regeneration, superheating of steam, and energy input and consumption in the heat circulation systems are analyzed. Thermodynamic cycles of pressurized water, organic cooled, liquid metal cooled, and gas cooled reactors are presented. (C.E.S.)

**29815** NUCLEAR REACTOR POWER PLANTS. (to Sulzer Freres, Societe Anonyme). British Patent 927,196. May 29, 1963. Priority date Aug. 19, 1960, Switzerland.

A power plant for a multipass superheated-steam-cooled reactor is patented. At least two evaporators operating at different pressure levels are provided to produce the vaporized working medium. The evaporators are heated by superheated vapor supplied from the reactor. The power plant has a turbine and compressor set, the working medium from one of the evaporators being expanded in the turbine to the common pressure level, while the working medium from another evaporator is compressed in the compressor to the common pressure level. It is claimed that the design increases plant efficiency. (M.P.G.)

**29816** METHOD OF MOUNTING THE REACTOR IN A SHIP WITH NUCLEAR PROPULSION. (to Escher Wyss SA). French Patent 1,281,815. Dec. 4, 1961. Priority date Mar. 22, 1960, Switzerland.

The reactor has a pressure vessel closed at its front with a removable cover. In order to replace the fuel elements, the ship is introduced into a chamber provided with biological shielding, and the bow of the ship is then removed with the aid of an overhead traveling bridge placed within the chamber. The biological shield separating reactor and ship's bow and the pressure vessel cover are then removed for access to the reactor fuel elements. (NPO)

**29817** IMPROVEMENTS RELATING TO NUCLEAR POWER PLANTS. (to Société Rateau). French Patent 1,287,582. Feb. 5, 1962. Filed Feb. 3, 1961.

A nuclear power plant in which the heat developed in the reactor is removed by a fluid in the vapor phase, is provided with two circuits. One circuit comprises a prime mover, in which the vapor expands, a condenser, and a pump repressurizing the fluid. The second circuit, in which the fluid is always in the vapor phase, comprises at least one mixer in which the repressurized liquid is introduced and vaporized in contact with the vapor in this circuit. This mixture is fed into the reactor. The vapor emerging from the reactor is divided into two portions feeding the said two circuits, respectively. (NPO)

**29818** NUCLEAR POWER PLANT. (to Sulzer Frères SA). French Patent 1,292,628. Mar. 26, 1962. Priority date Aug. 29, 1960, Switzerland.

The reactor cooling in a nuclear power plant is performed by two cooling cycles independent from each other, each of these cycles comprising a heat exchanger in which heat is transmitted to a working medium cycle. With respect to this working medium cycle, said heat exchangers are connected in series, so that in the heat exchanger corresponding to the first cycle the working medium is evaporated, while in the other one, corresponding to the second cycle, the evaporated working medium is superheated, from where it is led to the prime mover. The reactor exit temperature of the first cycle is lower than that of the second cycle. After having passed the superheating heat exchanger the fluid of the second cycle passes to an auxiliary heat exchanger in exchange relation with the working medium.

With respect to the working medium cycle, this auxiliary heat exchanger is branched in parallel to the heat exchanger corresponding to the first reactor cooling cycle. (NPO)

**29819** NUCLEAR REACTOR HEATED BOILER SYSTEM OF THE KIND COMPRISING A LARGE NUMBER OF SEPARATED BOILER VESSELS CONSISTING OF VERTICALLY, CYLINDRICALLY SHAPED CONTAINERS. André Huet. German Patent 1,146,070. Mar. 28, 1963, Priority date Mar. 10, 1958. France.

The boiler system described consists of a large number of separated boiler units which include separated pressure vessels provided with heat exchange surfaces and water drums, the latter being situated outside the pressure vessels. The cylindrically shaped pressure vessels are vertically arranged, and the reactor coolant is circulated through them in a downward direction. The heat exchange surfaces of each of the boiler units are located within two pressure vessels in such a way that one pressure vessel provides for evaporation and the other one for superheating the steam. Several pressure vessels have one water drum in common. The feed water pipes and the steam pipes are arranged to pass into the pressure vessels through their bottoms. (Gmelin Inst.)

## Production Reactors

**29820** (HW-SA-2937) NPR SAFETY AND CONTROL CIRCUITS. G. H. Strong (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 5, 1963. Contract AT(45-1)-1350. 46p.

Some of the control and safety circuits used in NPR are discussed. Their likenesses and differences and the philosophies from which they stemmed are considered. There are four principal groups of circuits used in NPR. They are: the rod scram circuit and ball drop circuit that ensure rapid reactor shutdown, a power setback circuit, an emergency cooling circuit, and all other miscellaneous control circuits. Figures and photographs are presented. (M.C.G.)

**29821** (HW-SA-2938) THE N-REACTOR FUEL PIECE CHARGING MACHINE. H. D. Lenkersdorfer and G. H. Strong (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 6, 1963. Contract [AT(45-1)-1350]. 31p.

The fuel-charging machine for the N-Reactor is described. It uses a monotube magazine long enough to contain all the fuel elements and dummies required to charge one process tube. The magazines are stored on wall brackets on each side of a large room just outside the inlet barrier wall in front of the reactor. The charging machine is mounted on a large elevator, which has a vertical travel of 33 ft. The machine is hydraulically operated, manually controlled, and capable of changing fuel elements at rates in excess of ten tons per hour under shutdown conditions. A typical charging machine cycle is described and photographs are shown. (M.C.G.)

**29822** MULTI-STAGE NUCLEAR REACTOR. (to Gutehoffnungshütte Sterkrade AG). French Patent 1,286,338. Jan. 22, 1962. Priority date Apr. 16, 1960, Germany.

In order to increase the yield of the conversion: ($U^{238} \rightarrow Pu^{239}$), a nuclear reactor working with natural uranium as nuclear fuel, is subdivided into two regions utilizing graphite and heavy water, respectively, as moderators. It is advantageous to provide a heavy water region surrounded by the graphite region and well an annular heavy water region between a central and marginal portion of the graphite region. Suitably this heavy water region is divided into a number of cylindrical spaces disposed along a medium diameter within the reactor. The aluminum walls of said spaces form in total a much smaller aluminum quantity in the reactor core, than it would be in the case of a single heavy water region. (NPO)

**29823** MULTI-STAGE NUCLEAR REACTOR AND METHOD OF EXPLOITATION OF SUCH A REACTOR. (to Gutehoffnungshütte Sterkrade AG). French Patent 1,287,212. Jan. 29, 1962. Priority date Apr. 28, 1960, Germany.

In order to increase the total conversion factor, a nuclear reactor is subdivided into different regions one of which being moderated with heavy water. In such a reactor generally the conversion factor increases when the ratio between the average flux in the heavy water region and, e.g., another graphite region, increases. For this reason high-temperature fuel elements are utilized in the heavy water regions, these fuel elements being constituted of uranium oxide clad with zirconium, while each region has individual cooling circuits adapted on its power production. According to a first embodiment high-temperature cooling cycles in the heavy water region are utilized for power production, while the low temperature cycles of, e.g., the graphite region, supply process heat. In another embodiment the coolant flows emerging from the different reactor regions are intermixed to create a single outer circuit. (NPO)

## Research Reactors

**29824** (AEEW-R-85) MEASUREMENT AND CALCULATION OF FAST NEUTRON FLUX IN A ZERO-ENERGY REACTOR. D. H. Day, W. N. Fox, and H. R. Hyder (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1963. 32p.

An activation technique for measuring relative fast neutron fluxes is described which has some advantages over the normal method using uranium-238 fission. The technique is based on the formation of rhodium-103 after inelastic scattering of neutrons above 100 kev. This isomer decays with a 57.4-minute half life giving an easily measurable $\gamma$ activity. The energy dependence of the inelastic scattering cross section of rhodium-103 is similar to that of the fission cross section of uranium-238, thus making the results of direct relevance to reactor calculations. Using the rhodium-103 activation technique, measurements are made of the fast neutron flux distribution in a typical pressure tube heavy water lattice and are compared with theoretical calculations using the Monte Carlo method. (auth)

**29825** (AEEW-R-211) CONTROL ROD STUDIES IN AN EXPONENTIAL ASSEMBLY. M. Gibson, K. G. Greenhouse, T. Wass, and A. N. Buckler (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1963. 53p.

Results of control rod worths in a graphite exponential assembly are presented and some comparison with theoretical prediction is made. The measured change of relaxation length is interpreted as a change of leakage, on the assumption that the materials buckling of the reactive medium is unchanged on insertion of the control rod.

Boron steel rods of different diameters and different enrichments, boron carbide, and cadmium rods are examined in a range of environment spectra including thermal. Comparison of the measured reactivity changes and flux distributions, caused by the control rods, with calculation based on a correlation of critical reactor experiments on the same rods, demonstrates that the exponential technique is justified, thus offering a significant saving in time and cost over equivalent experiments in a critical assembly and giving comparable accuracy. The measurements are compared with calculations based on a theoretical approach currently being developed at AEE, Winfrith and the agreement is encouraging. (auth)

**29826** (ANL-6713) CRITICAL STUDIES OF A SMALL URANIUM CARBIDE-FUELED REACTOR WITH A BERYLLIUM REFLECTOR. (ZPR-III ASSEMBLY 40). R. L. McVean, P. I. Amundson, G. S. Brunson, and J. M. Gasidlo (Argonne National Lab., Idaho Falls, Idaho). Apr. 1963. Contract W-31-109-eng-38. 19p.

A small, lightweight, uranium carbide-fueled reactor with a beryllium reflector surrounding the core was mocked up as Assembly 40. It was determined that the presence of beryllium in the axial and radial reflectors did not endanger the safe loading and operation of the critical assembly. The actual experiment consisted of determination of the critical mass, measurement of the reactivity coefficients for a large number of fissile and nonfissile materials, the performance of radial and axial fission traverses, and measurement of central fission ratios. The effectiveness of the radial beryllium reflector as a control mechanism was determined and the Rossi-alpha was measured. (auth)

**29827** (HW-77638) TRANSIENT FISSION PRODUCT POISONING IN PRTR. R. I. Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 20, 1963. Contract AT(45-1)-1350. 26p.

The calculation of transient fission product poisoning in the Plutonium Recycle Test Reactor (PRTR) is complicated by the variety of fuel compositions and exposures normally present in the core. As a result, the poisoning must be computed on an element-by-element basis, appropriately weighed, and summed to obtain the actual reactor poisoning. The general differential equations for transient fission product poisoning and their time-dependent solutions are presented, together with the adaptation of these equations to an individual fuel element poisoning calculation and the computation of the weighed total reactor poisoning from these individual calculations. The details of a computer program (POWPOI) written to perform these calculations and to present the results in a form readily usable by the reactor operating staff are included. (N.W.R.)

**29828** (HW-77732) A DESCRIPTION OF THE HIGH TEMPERATURE LATTICE TEST REACTOR. W. W. Brown and R. E. Heineman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 27, 1963. Contract AT(45-1)-1350. 23p.

A High Temperature Lattice Test Reactor (HTLTR) now under design by Hanford Laboratories is described. A central experimental core region may be removed, and any solid-moderated reactor lattice may be inserted for testing. Reactivity transients of the test lattices associated with changes in temperature of either moderator or fuel can be obtained in support of design and hazards analyses of proposed power reactors. The experimental equipment and facilities associated with the reactor are also described. A listing of the scope design data is included as well as diagrams showing examples of core loadings. (auth)

**29829** (JüL-111-RE) AKTIVITÄTSMESSUNGEN IM ABLUFTSYSTEM UND PRIMÄRKÜHLKREIS DES REAKTORS FRJ-1 (MERLIN) BEI 100 kW. (Activity Measurement in the Waste Air System and Primary Cooling Circuit of the Reactor FRJ-1 (Merlin) at 100 kw). K. L. Frenkler (Kernforschungsanlage, Julich, Germany). May 1963. 31p.

The radioactivity in the primary cooling circuit and waste-air system of the MERLIN Reactor (FRJ-1) was investigated in the scope of the second phase of the startup program at a reactor power of 100 kw. In the waste-air filter no collection of radioactive nuclides was observed. The detection of $N^{16}$ in the air directly over the reactor water surface could not be made. The concentration of $Ar^{41}$ in the drainage tube was determined to be $1 \times 10^{-3}$ $\mu c/cm^3$. In the reactor water the radioisotopes $Na^{24}$, $Ar^{41}$, $Kr^{87}$, $Kr^{88}$, $I^{134}$, and $I^{133}$ were identified. The total activity of the water 2 hours after shut-down of the reactor was $10^{-4}$ $\mu c/cm^3$. Alpha emitters could not be detected in the water. Chemical analysis gave a value of 9.4 ppm for the $SiO_2$ content of the water. The conductivity amounted to an average of 2.5 $\mu$sec/cm. (tr-auth)

**29830** (JÜL-112-RE) NEUTRONENFLUSSMESSUNGEN AM FRJ-1 (MERLIN)BEIN LEISTUNGEN VON 40 W–100 kW. (Neutron Flux Measurements in the FRJ-1 (Merlin) at Powers of 40W to 100kW). H. J. Bormann and W. Porschen (Kernforschungsanlage, Jülich, Germany). Apr. 1963. 46p.

In the scope of the second startup phase of the FRJ-1 (MERLIN), the thermal and epithermal flux distributions in the experimental installation of the reactor were measured with the help of an activation probe. At the boundary of the core the fast flux was determined with phosphate glass and sulfur films, and the properties of the films were investigated. It is shown that for use of phosphate glass films, the long-lived portion of the thermal activation must be considered. The sulfur films showed no interfering activity. The fast neutron flux at the boundary of the core was on the order of $10^7$ n $cm^{-2}$ $sec^{-1}$ $watt^{-1}$. (tr-auth)

**29831** (JüL-122-RE) STRAHLUNGSFELDMESSUNGEN AM FRJ-1 (MERLIN) BEI LEISTUNGEN BIS 100 KILOWATT. (Radiation Field Measurement on FRJ-1 (Merlin) with Operation at 100 Kilowatt). Herbert Jahn (Kernforschungsanlage, Jülich, Germany). June 1963. 35p.

During the second startup phase of the FRJ-1 (MERLIN) at a power up to 100 kw the radiation field due to gamma radiation as well as fast and thermal neutrons in the reactor was measured. Geiger-Mueller tubes, ionization chambers, and $BF_3$ proportional counters were used as radiation detectors. At the periphery of the reactor tube a radiation level of about 40 mrem/hr was found. (M.C.G.)

**29832** (JüL-124-RE) REAKTORKINETISCHE UNTERSUCHUNGEN UNTER VERWENDUNG EINES ANALOGRECHNERS. (Reactor Kinetic Studies with the Use of an Analog Computer). K. J. Kalker (Kernforschungsanlage, Jülich, Germany). June 1963. 44p.

The functions of electronic analog computers are described. Problems investigated included perturbation and temperature behavior of the FRJ-2 (DIDO), as well as calculation of the xenon poisoning of FRJ-1 (MERLIN) and FRJ-2 (DIDO). The errors in calculation resulting from non-linear terms on the analog computer are considered. (M.C.G.)

**29833** (NARF-62-14T) FIRST OPERATIONAL YEAR OF THE RTA. J. T. Pancoast and E. L. Jordan (General

Dynamics/Fort Worth. Div. of General Dynamics Corp. Nuclear Research and Development Lab., Fort Worth, Tex.). Feb. 1, 1963. Contract AF33(657)-7201. 103p. (FZK-9-179)

On 24 January 1961 the Reactivity Test Assembly (RTA), a heterogeneous, light-water, unpressurized, fully enriched system that operates as a zero-power reactor, at General Dynamics/Fort Worth was brought critical for the first time. During the year following, the RTA was used in 11 major experiments that covered the operational testing and continued research for the two 3-Mw reactors at the Nuclear Aerospace Research Facility at GD/FW. (auth)

**29834** (PAN-108/Doz.) OBSHCHAYA DOZIMETRICHESKAYA SYSTEMA REAKTORA ESHA I KRITICHESKOI SBORKI MARYLA. (Common Radiation Protection System for the Reactor EWA and the Critical Assembly Maryla). B. Filipzak (Bogdan Filipyak), Kazimezh Mlitski, and Krzysztof Zarnowiecki (Kshishtof Zharnovetski) (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Mar. 1963. 9p.

Presented at Conference on Physics and Reactor Technology, Prague, April 1963.

A stationary dosimetric system is described for the critical assembly Maryla. The system satisfies the basic requirements of radiological protection connected with the assembly and utilizes the actual dosimetric system of the reactor Eva. (auth)

**29835** (PAN-405/IX) INVESTIGATION OF THE INFLUENCE OF A SCATTERING SAMPLE ON NEUTRON TEMPERATURE DISTRIBUTION IN THE VVR-S REACTOR CORE. Tadeusz Rzeszot and Eugeniusz Warda (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Mar. 1963. 15p.

Neutron scattering samples (water, graphite, and lead) were placed in an aluminium tube passing through the reactor core in order to investigate their influence on neutron temperature distribution. Measurements were performed by the boron-glass filter method. The neutron temperature distribution in the reactor core was measured by shifting the scattering sample along the tube. Asymmetry of the distribution seemed to result from asymmetrical scattering of thermal neutrons on water molecules. (auth)

**29836** (PAN-406/XII) KANAL AVTOMATICHESKOGO REGULIROVANIYA REAKTORA NULEVOI MOSHCHNOSTI ANNA. (The Automatic Control System of the Zero Power Reactor Anna). W. Filipczak (Veslav Filipchak), Ezhi Gzheishchak, and Andzhei Kshytski (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Mar. 1963. 13p.

Presented at Conference on Physics and Reactor Technology, Prague, April 1963.

The automatic control channel of the reactor Anna is described. It is fully transistorized, driven by a two phase a-c motor of 0.67 w. The main elements of the system — the power setting, device, the amplifier, and the driving mechanism — are discussed. Results of the testing by a combined simulation method are given and analyzed. The laboratory stand was composed of the control system considered, control rod mock-up, and reactor kinetics simulator. (auth)

**29837** (PAN-413(XII)) UKLAD REGULACJI I ZABEZPIECZEN REAKTORA MOCY ZEROWEJ ANNA. (Control and Safety System of the Zero Power Reactor ANNA). N. (Nadezhda) Filipczak (Filipchak) (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Mar. 1963. 20p.

The control and safety system of the zero power reactor Anna is described. Since Anna is the mockup of the 2nd Polish High Flux Research Reactor, the control system mentioned is the mockup for the research reactor. All the features of the high-flux research reactor control system are inherent to Anna, i.e., three channels (log-pulse, log-current, and linear-current) with overlapping ranges, two-out-of-three principle, continuous control of operation, conservation of the preset power level, and reactor period. (auth)

**29838** (PAN-420/XI) DOKLAD OB ISPOL'ZOVANII I EKSPLUATATSII REAKTORA TIPA VVR-C V POL'SHE ZA 1961–1962 GODA. (Operation of the WWR-S Reactor in Poland and in the Period 1961–1962). Jerzy Aleksandrowicz (Ezhi Aleksandrovich) (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Mar. 1963. 47p.

Presented at Conference on Physics and Reactor Technology, Prague, April 1963.

The experimental equipment used in the work at the horizontal reactor channels is listed. Diagrams of the utilization of the nominal reactor power and core loading are given, the reactivity fractions of the separate fuel assemblies are detonated, together with the diagram of reactivity versus burnup. Reactor channels and space used for sample irradiation and isotope production are described, and the total number of irradiations is given. Results of the measurements connected with the routine reactor operation are quoted, namely: analysis of water purity in the primary circuit, analysis of the work of the ion exchanger and mechanical filter, and analysis of air activity in the special ventilation system. Data are given concerning radiation protection of personnel, including individual monitoring. Leak testing of the fuel elements is discussed. Damage of the reactor equipment and appearance of alarm signals are described. (auth)

**29839** (PAN-423/Doz) MOZLIWOŚĆ WYKORSYSTANIA NIEKTÓRYCH KANALÓW REAKTORA WWR-S JAKO ŹRÓDLA WZORCOWEGO STRUMIENIA NEUTRONÓW TERMICZNYCH. (Possible Use of Some WWR-S Reactor Channels as a Standard Thermal Neutron Source). Stanislav Pshona (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Mar. 1963. 9p.

The thermal neutron beams from some of the WWR-S reactor channels can be used for experiments in which the stability of neutron flux over longer time periods is important. It is proved in a series of measurements in the chosen channels that the variation of the neutron flux with time is accurately measured by the reactor control equipment. (auth)

**29840** (PAN-424/XI) ISSLEDOVANIE OKHLAZHDENIYA TEPLOVYDELYAYUSHCHEGO ELEMENTA REAKTORS VVS V TSILINDRICHESKIKH KANALAKH I V KANALE S PEREMENNYM SECHENIEM V VODYANOI PETLE. (Investigation of the Cooling of the WWR-S Reactor Fuel Element in Cylindrical Channels and in a Channel with Variable Cross-Section in the Water Loop). Witold Byszewski (Vitol'd Byshevski), Miroslyav Shlekhta, and Jerzy Aleksandrowicz (Ezhi Aleksandrovich) (Polish Academy of Sciences. Inst. of Nuclear Research, Swierk). Mar. 1963. 40p.

Presented at Conference on Physics and Reactor Technology, Prague, April 1963.

The experimental equipment and the test methods and measurements in the water loop of the Polish WWR-S reactor are described. Results prove that the heat transfer is intensified and the surface temperature distribution along the fuel element is flattened due to the variation of

the channel cross section. The experimental results are compared with the theoretical calculations carried out according to various formulas. From the experimental data a formula is deduced for the calculation of local heat transfer coefficients. These experimental results form a basis for the increase of the WWR-S reactor nominal power, when using new fuel assemblies with channels of variable cross section. (auth)

**29841** (TID-19001) HWCTR CONTROL ROD AND SAFETY ROD DRIVE SYSTEMS. S. H. Kale (Du Pont de Nemours (E. I.) & Co. Savannah River Lab.). [July 1963]. Contract AT(07-2)-1. 27p.

The Heavy Water Components Test Reactor (HWCTR) is a pressurized, $D_2O$ reactor designed for operation up to 70 Mw at 1500 psig and 315°C. It has 18 control rods and six safety rods, each driven by an electric motor through a rack and pinion gear train. Racks, pinions, and bearings are located inside individual pressure housings that are penetrated by means of floating ring labyrinth seals. The drives are mounted on the reactor vessel top head. Safety rods have electromagnetic clutches and fall into the reactor when scrammed. The reliability and performance of the rod drives are very good. Seal leakage is well within design limits. Recent inspections of seals and control rod plants showed no evidence of crud buildup or stress corrosion cracking of type "17-4PH" stainless steel components. (auth)

**29842** ESSOR—A SPECIFIC EXPERIMENTAL REACTOR FOR THE EURATOM ORGEL PROGRAM. J. P. Crette (Groupement Atomique Alsacienne Atlantique, Paris), R. Harde, and J. C. Leny. Atomwirtschaft, 8: 357-66(June 1963). (In German)

The Euratom Commission agreed to the construction of a specific experimental reactor, ESSOR, for the study of the technological problems which still exist for reactors of the ORGEL type. The ESSOR installation is being built in the Ispra common research center. Reactors of the ORGEL type are heavy water reactors with good neutron economy whose cooling is accomplished by a low melting point mixture of terphenylene. This mixture, under the influence of heat and radiation, is liable to decompose but the effect becomes significant only at temperatures above 420°C. Operation with liquid temperatures of 400°C is therefore possible without further complication. An essential part of the ORGEL development program is the testing of a complete cooling channel. Experiments with various constructions for the cooling channels, long-term experiments with the channel including the fuel element, and life testing of the fuel elements in representative numbers of pieces are provided for in the ESSOR reactor. The aim of these investigations is to explore the mechanical behavior of the complete ORGEL channel under operating conditions which are typical of power reactors. The lay-out, construction, and detailed system of the reactor installation are described. (auth)

**29843** ESSOR. Claude Chassignet. Euratom Bull., No. 2, 12-17(June 1963). (In English)

The design and anticipated operating conditions of the ESSOR, an organic-cooled, heavy-water-moderated reactor are presented. (C.E.S.)

**29844** IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 924,844. May 1, 1963. Priority date Nov. 12, 1959, United States.

The design of a reactor for producing radioactive isotopes is patented. The design provides a method and apparatus for simultaneously and uniformly irradiating a plurality of samples. The pool-type reactor has a reflector extending around the core. A circular recess is formed in the reflector and also extends around the core. A plurality of spaced-apart containers can be suspended in the recess and moved continuously through the circular path defined by the recess, so that specimens placed in the containers are uniformly exposed to radiation from the core. The apparatus for suspending and moving the containers is described. (M.P.G.)

**29845** A MAGAZINE FOR SUBJECTING SAMPLES TO TREATMENT IN NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,219,406. May 17, 1960. Filed Dec. 31, 1958.

A device is designed for the production of a large number of isotopes in a relatively small space by subjecting individual chemical samples, each enclosed in an aluminium container, to treatment in a nuclear reactor. The device consists essentially of a magazine comprising a plug section to fit in a corresponding hole in the biological shield of the reactor, a housing projecting from the plug section and adapted to extend into the interior of the reactor, and an external control head. In the housing is mounted a number of individual carriers, each having a series of axially extending storage cells for housing and retaining an isotope container and an open cell which constitutes a transport passage to enable containers to pass from one carrier to the next. In order to bring any cell in a carrier into register with the cells in adjoining carriers the carriers are selectively rotated. The displacement of the isotope containers is performed by pneumatic means. (NPO)

**29846** CRYOGENIC DEVICE FOR IRRADIATION AT LOW TEMPERATURE. (to Commissariat à l'Énergie Atomique). French Patent 1,252,681. Dec. 26, 1960. Filed Dec. 15, 1959.

In a cryogenic device for irradiation of samples at low temperature, a continuous circulation of the cryogenic fluid within a thermally insulated space is maintained between a first region, exposed to a high irradiation flux and enclosing the sample, and an adjoining region with a low irradiation flux and in which the fluid is condensed on a heat exchanger. The flow from the heat exchanger to the first region takes place by gravity. The heat exchanger is cooled by a second cryogenic fluid of the same kind as the first one, but having a lower pressure and, e.g., a lower purity. According to another embodiment this second fluid is of a different kind and has at the same pressure a lower boiling point. (NPO)

**29847** CRYOGENIC DEVICE FOR IRRADIATION AT LOW TEMPERATURE. (to Commissariat à l'Énergie Atomique). French Patent 1,252,681, first addition 77,733. Mar. 5, 1962. Filed May 18, 1960.

The Fr.P. 1,252,681 relates to a cryogenic device comprising within a thermal insulated space a continuous circulation of the cryogenic fluid between a first region, exposed to a high irradiation flux, and an adjoining region of low irradiation flux in which the evaporated fluid is condensed on a heat exchanger. The present addition relates to an improved device with an easy and fast accessibility of the irradiation space. This is obtained by dislocating the longitudinal axis of the lower part of the device, immersed in the reactor pool, with respect to the upper part crossing the water level. In this way any escape of direct radiation emitted from the reactor core is prevented. The dislocation is at a sufficient distance from the water level to ensure an adequate shielding. A removable tubular piece is

provided for the respective connection of the different spaces in the lower part of the device with their corresponding extension in the upper part. For the removal of said connexion piece, the device is raised so that the fluid-tight seals of this connection are all above the water level. (NPO)

**29848** EXPERIMENTAL LOOP FOR A NUCLEAR REACTOR. (to Commissariat à l'Énergie Atomique). French Patent 1,267,817. June 19, 1961. Filed May 20, 1960.

An experimental loop for a swimming-pool reactor comprises two parts placed inside and outside the pool, respectively. The part immersed in the pool water comprises a thermally insulated pressure tube into which the elements to be irradiated are placed and which is provided with a reflector part in order to create a zone of uniform neutron flux distribution. The coolant cycle in this tube is closed by two cycles branched in parallel, i.e., a main cycle in the immersed portion of the loop and a measuring cycle passing through the outside portion of it. The said main cycle comprises a filter, a flowmeter, a pump, and an adjustable bypass with a heat exchanger. The measuring cycle comprises two flexible tubes, connecting the outside portion of the loop with the pressure tube, a pressure control device, a burst slug detector, and a second heat exchanger. The pressure control is performed by alternative connection of the loop with a high pressure fluid source and a discharge line. (NPO)

**29849** EXPERIMENTAL REACTOR HAVING DIFFERENT ZONES. (to Siemens-Schuckertwerke AG). French Patent 1,269,403. July 3, 1961. Priority date Aug. 27, 1959, Germany.

To examine the behavior of reactor lattices of planned power reactors it is known to use experimental reactors into which the lattice to be studied is placed. Measures are taken for reproducing the neutron spectrum to be expected in the power reactor. Generally the lattice is placed in a central zone of the experimental reactor while enriched fuel elements are placed in a marginal zone. According to this patent, the flux of fast neutrons and the flux of thermal neutrons as well as densities of them are controlled by changing the radial position of the enriched fuel elements with respect to the lattice to be studied. E.g., an outward displacement necessarily results in an increase of the liquid moderator layer between said elements and the lattice, and thus in an increase of the thermal flux with respect to the fast flux. This has the advantage that the critical state of the reactor is not much influenced. (NPO)

**29850** CORE OF A NUCLEAR REACTOR FOR STUDYING OF MATERIALS UNDER IRRADIATION. (to Commissariat à l'Énergie Atomique). French Patent 1,269,631. July 10, 1961. Filed May 20, 1960.

The core block of a nuclear reactor comprises an immersed pressure container having a closing cover at its top. The entrance ducts for the pressurized cooling water are connected laterally at the upper region of the pressure container wall and serve also for increasing the mechanical stability. The cooling water enters the container via divergent deflector nozzles. The fuel elements are placed in such a way that vibrations due to the high coolant velocity are prevented. Tubes for the control rods are provided passing through the fuel element region, the movement of the rods being controlled from the bottom of the reactor. The coolant flows via deflectors into the outlet ducts connected at the wall of the container in the proximity of its bottom which is closed in a tight manner with a shielding plug through which the driving rods for the control rods pass. (NPO)

**29851** INDEPENDENT LOOP OF A SWIMMING POOL REACTOR FOR EXAMINING THE PROPERTIES OF MATERIALS UNDER IRRADIATION. (to Commissariat à l'Énergie Atomique). French Patent 1,269,632. Sept. 10, 1961. Filed May 20, 1960.

This loop is immersed in the pool and has a cooling circuit comprising a circulating pump, a heat exchanger, the experimental channel with its thermal insulation, and a reflector arranged on the outside of it. The whole loop installation is mounted on a carriage traveling on an adjustable console mounted on the side walls or on the bottom of the pool. Said heat exchanger has a tube bank over which flows the pool water in forced or in natural circulation. The said thermal insulation is suitably constituted by an annular space comprised between concentric tubes and filled with a stagnant fluid. The experimental channel which is vertically arranged has at its top a closure plug supporting a basket, containing the material under examination and being fixed to the channel end with a fast-locking device. (NPO)

**29852** EXPERIMENTAL REACTOR. (to Licentia Patent Verwaltungs GmbH). French Patent 1,286,560. Jan. 22, 1962. Priority date Sept. 24, 1960, Germany.

The parts of an experimental nuclear reactor are arranged according to the principle of a box of bricks. The parts comprise graphite moderator reflector blocks and special containers enclosing the nuclear fuel and an additional moderator, e.g., constituted of water. According to another embodiment, the fuel elements are enclosed by a synthetic material containing hydrogen, e.g., polythene, so that there is no container necessary to enclose the fuel and the additional moderator. The said parts containing the nuclear fuel are arranged inside a marginal zone enclosing a central zone occupied by graphite blocks, so that after the removal of a number of these blocks, said zone shows stable cavities adapted to receive elements, the deportment of which has to be examined. (NPO)

# SPACE APPLICATIONS AND TECHNOLOGY

*Refer also to abstract 29076.*

**29853** (MND-1123) RADIOISOTOPE FUELED AUXILIARY POWER UNIT. Quarterly Progress Report No. 2, April–July 1957. (Martin Co., Baltimore). Contract AT (30-3)-217. 76p.

Development of a radioisotope heat source for a satellite power plant is summarized. Possible operational hazards during the lifetime of the system are discussed. The development of the boiler design, fabrication of cerium compounds, pump assembly, turbine, and mercury heat transfer medium are summarized. The effect of gamma radiation on Kodak Microfile film is studied. (N.W.R.)

**29854** (MND-2584-4) RADIOISOTOPE SEMICONDUCTOR AND THERMOELEMENT RESEARCH AND DEVELOPMENT. Final Technical Report, February 13, 1961–July 17, 1962. N. G. Asbed (Martin-Marietta Corp. Aerospace Div., Baltimore). Contract AT(30-1)-2698. 74p.

A description is given of work in support of the concept that a radioisotope can be made an integral part of the thermoelectric arm of a generator and that the decay energy of the emitted particles can be converted to electricity by direct conversion. In particular, n-type strontium and cerium titanates were prepared to house strontium-90 and cerium-144, respectively. The blend consisting of $SrTiO_3$ (+20-wt % Fe) +20-wt % $CeTiO_3$ has an average figure of merit of $1.9 \times 10^{-4}$°$C^{-1}$ between 200 and 1100°C; the corresponding thermoelectric conversion efficiency is ~4%. Strontium titanate was prepared by reacting strontium carbonate and titanium dioxide in air. The addition of 20-wt % pyrophoric iron and the subsequent reduction in dry hydrogen at 1475°C rendered the titanate into an n-type semiconductor with a thermoelectric figure of merit of $1.1 \times 10^{-4}$ per degree centigrade at 600°C. This material withstands temperatures to 1200°C in the absence of oxygen, without a deterioration of its thermoelectric properties. The material is mechanically strong and hard. Cerium titanate was prepared for the first time by a process similar to the one used to make semiconducting strontium titanate, and was shown to have the formula $CeTiO_3$. A thermoelectric arm of iron-doped strontium titanate was prepared, with 20 curies of strontium-90 concentrated as an ingredient of the thermoelectric material at one end. This device had an open-circuit emf of 1.20 millivolt, and delivered 0.48 microwatt to a matched load. A program for the IBM 7090 computer was modified to permit optimization of a thermoelectric arm, of varying composition, which contains an internal heat source. (auth)

**29855** (MND-P-3008) RADIOISOTOPE FUELED AUXILIARY POWER UNIT. Quarterly Progress Report No. 11, July–September 1959. (Martin Co. Nuclear Div., Baltimore). Contract AT(30-3)-217. 144p.

Progress made in the development of the radioisotope-fueled thermoelectric generators (SNAP-IA, SNAP-IIIA, -B, -C, and -D, and SNAP-VII) is reported. SNAP-IA development is reported in relation to the overall system, structure and containment, heat element development and testing, environmental and qualification testing, ground handling and transportation, conversion system, and operational hazards. SNAP-III-A, -B, -C, and -D development of the thermoelectric generator is concerned mostly with molybdenum fuel capsule development, vehicle integration, fuel element design and testing, generator design and testing, and hazards testing. SNAP-VII development is concerned with generator design, fuel development, program management and integration, and hazards analysis. (N.W.R.)

**29856** (MND-P-3009) RADIOISOTOPE FUELED AUXILIARY POWER UNIT. TASK 2. Quarterly Progress Report No. 12, September–December 1959. (Martin Co. Nuclear Div., Baltimore). Contract AT(30-3)-217. 115p.

Progress made in the development of the radioisotope-fueled thermoelectric generator (SNAP-IA) is reported. Information is given on system design, material analysis, hazards analysis, fabrication techniques, and system and components testing. Special emphasis is given to the cerium fuel development program. (N.W.R.)

**29857** (NP-12888(Vol.1)) SPACE ELECTRIC POWER SYSTEMS STUDY. Final Report, November 1961 through December 1962. Volume 1. F. X. Dobler, C. L. Doughman, G. W. Ernsberger, et al. (Westinghouse Electric Corp. Aerospace Electric Div., Lima, Ohio). Contract NAS5-1234. 177p.

The general system arrangement is given, and those system components necessary to efficiently (considering weight and power losses) supply a variable voltage d-c load at constant power are defined. The system arrangement from turbine shaft to d-c bus includes: a generator; an exciter-regulator, for generator excitation control; a transformer; a rectifier, and switch gear. The switch gear includes circuit breakers, tap changers and bank switches as needed. The components and materials for each system component were selected on the basis of temperature, frequency, power rating, and availability. In most cases, the generator magnetic materials are Hiperco 27 for stator and SAE 4340 for rotor. The conductors are Cu insulated with an inorganic material. Transformer materials include Si–Fe for core; Cu conductors; and insulation of mica, glass and asbestos. Si semiconductor devices were chosen in all cases because of weight and power ratings. The general approach to cooling each system component is discussed along with the mathematical development of the approach chosen. All components are liquid cooled with K for the generator, NaK or K for high-temperature power conditioning equipment, and MIPB for low temperature power conditioning equipment. A method of determining size, weight and impedance of transmission lines is developed. The approach was to develop equations for the resistance of hollow and solid conductors, then balance the conductor power losses ($I^2R$) to the amount of power that can be radiated from the surface of the conductor. (auth)

**29858** (NP-12888(Vol.2)) SPACE ELECTRIC POWER SYSTEMS STUDY. Final Report, November 1961 through December 1962. Volume 2. F. X. Dobler, C. L. Doughman, G. W. Ernsberger, et al. (Westinghouse Electric Corp. Aerospace Electrical Div., Lima, Ohio). Contract NAS5-1234. 329p.

This volume provides all the parametric data developed for each system component of the 1-to-10 Mw study. Generator ratings of 1, 2, 5, and 10 Mw at speeds from 10 to 24 thousand rpm and coolant temperatures between 500 and 1100°F are considered. All generator designs are limited by the allowable stress of the rotor material for a combi-

nation of speed and temperature. The combination usually decreases as the rating increases. Because of these limitations, the specific weight generally increases with rating. Additional designs at lower speeds, below 10,000 rpm, were added to the study because NASA indicated that turbine speeds might have to be decreased. Designs at 1, 2, and 5 Mw are included. The effect of advanced materials on generator weight and losses is also examined. The effect of better magnetic and insulation materials caused weight reductions of about 25% and efficiency improvements of about 0.5%. The 1-, 5-, and 10-Mw transformer designs with maximum temperatures of 500, 1000, and 1500°F show that except for some limitations the electro-magnetic weight is practically independent of rating for equal operating conditions and efficiency. The designs also show that Al conductors offer no weight or efficiency advantage over copper conductors. The parametric data for the exciter-regulator and the rectifier show that the Si semiconductors are the best choice from a weight standpoint. The data also show that high-temperature devices do not offer any weight or efficiency advantage because their ratings are too low for this application. Parametric data for circuit breakers, tap changers, and bank switches are included to evaluate the effect of step changes in direct voltage. (auth)

**29859** (NP-12888(Vol. 3)) SPACE ELECTRIC POWER SYSTEMS STUDY. Final Report, November 1961 through December 1962. Volume 3. F. X. Dobler, C. L. Doughman, G. W. Ernsberger, et al. (Westinghouse Electric Corp. Aerospace Electrical Div., Lima, Ohio). Contract NAS5-1234. 125p.

Three conceptual system designs based upon three missions are presented. All designs are for 1 Mw ratings. The first design is based on a variable output of 600 to 6000 volts. The second design is for a 4000-volt system and the third is for a 20,000-volt system. The specific weights of the first and third system are about equal while system number 2 has the lowest specific weight. The second system is lighter because no transformer is required. A tabular summary for each system is included. (auth)

**29860** (NP-12888(Vol.4)) SPACE ELECTRIC POWER SYSTEMS STUDY. Final Report, November 1961 through December 1962. Volume 4. F. X. Dobler, C. L. Doughman, G. W. Ernsberger, et al. (Westinghouse Electric Corp. Aerospace Electrical Division, Lima, Ohio). Contract NAS5-1234. 143p.

The parametric data and one preliminary system design for the extended portion of the contract are presented. The ratings of the parametric data are 250 and 500 kw at 5000 volts. As shown by the preliminary design summary, the specific weight of the system is higher than the specific weight of the 1 Mw system. The primary reason for the increase is this system supplies auxiliary a-c loads, the generator operates at a lower frequency, and the general concept of weight savings as system ratings increase is borne out for this type of system in ratings less than 1 Mw. (auth)

**29861** STATIC NUCLEAR THERMOELECTRIC SYSTEM FOR SPACE. P. E. Kueser (Westinghouse Electric Corp., Lima, Ohio), P. S. Merrill, and F. G. Tauch. Appl. Ind., No. 64, 402-5(Jan. 1963).

A completely static nuclear-powered thermoelectric generator is discussed. The reactor, designed for SNAP-10, uses $U_{235}$–zirconium–hydride fuel moderator and is capable of operating a thermoelectric generator at a hot-side temperature of 1,000 to 1,200°F. A prototype thermoelectric generator is described that produced 250 watts of electric power at spacing operating temperatures. Waste-heat radiators for the system, having constant and tapering fin thicknesses, are discussed. Curves are presented of performance versus fin number and length for both tapered and constant-thickness fins. Weight and electric power capability of a present state-of-the-art thermoelectric generator-radiator system is presented in curve form and shows a 245-pound weight for a 250-watt system exclusive of the reactor and shielding. (auth)

**29862** NUCLEAR ROCKETS FOR PRACTICAL SPACE FLIGHT. R. W. Bussard (Space Technology Labs., Inc., Los Angeles). New Scientist, 18: 706-10(June 27, 1963).

The use of nuclear energy in achieving better rocket propulsion is discussed. The application possibilities of gas-core, liquid-fuel, and solid-core reactors along with arc-jets and electrostatic and hydromagnetic engines are described. Problems for future research are listed. (M.C.G.)

**29863** EXPERIMENTAL RESEARCH ON ELECTRIC PROPULSION. NOTE IV. RESEARCH ON THE ELECTRIC ARC ROTATING IN A MAGNETIC FIELD, AIMING AT ITS USE IN SPACE PROPULSION. Aurelio C. Robotti and Mario Oggero (Politecnico, Turin). Ric. Sci., Rend. (2), 3: 20-7(Jan. 1963). (In Italian)

Work on arcs rotating in a magnetic field is described. Particular care was taken about the design of the electrodes in order to achieve long-time operation. Successful tests of over an hour were carried out. (auth)

**29864** EXPERIMENTAL RESEARCH ON ELECTRIC PROPULSION. NOTE V. EXPERIMENTAL STUDY OF A MAGNETIC FIELD STABILIZED ARC-JET. Aurelio C. Robotti and Mario Oggero (Politecnico, Turin). Ric. Sci., Rend. (2), 3: 28-35(Jan. 1963). (In Italian)

A number of experiments carried out on a magnetic-field-stabilized arc-jet, using nitrogen as a propellant, is described. (auth)

# WASTE DISPOSAL AND PROCESSING

*Refer also to abstract 29135.*

**29865** (AERE-R-4314) INVESTIGATIONS INTO THE USE OF A CENTRIFUGED BED OF VERMICULITE FOR THE DECONTAMINATION OF RADIOACTIVE EFFLUENT. J. H. Clarke, T. D. Wright, and R. J. Berryman (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1963. 27p.

It was shown that a centrifuge offers a method of obtaining high flow rates through a bed of vermiculite without seriously affecting its ion-exchange properties. Good decontamination factors were obtained on both laboratory and pilot plant scale. It is proposed that further scaling up to plant size is practicable. (auth)

**29866** (CRER-1146) THE MOVEMENT OF TRITIUM FROM THE CHALK RIVER LIQUID DISPOSAL AREA. P. J. Parsons (Atomic Energy of Canada Ltd., Chalk River, Ont.). Apr. 1963. 16p. (AECL-1739)

A groundwater survey showed that tritium, as tritiated water, has migrated from the Liquid Disposal Area and spread beneath 70 acres of adjoining land. An estimated 8,250 C beneath South Swamp and Perch Lake Swamp are advancing towards Perch Lake. A weak "front" has already reached the lake, but the concentrations are expected to rise to 10 times the present value in 2 years. A further increase is anticipated in 4 years time. (auth)

**29867** (NDL-TM-8) AN EVALUATION PROGRAM FOR RADIOACTIVE WASTE INCINERATION. Richard Dennis, William Kyritsis (Harvard Univ., Boston. Air Cleaning Lab.); and Ernest W. Bloore (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Mar. 1963. Contract AT(30-1)-841. 24p.

A 50 lb/hr incinerator for the concentration of low-level radioactive combustible waste is described and evaluated along with gas-cleaning equipment associated with the incinerator. A proposed program for testing the equipment is included. (N.W.R.)

**29868** (PAEC(D)HP-622) SOLID WASTE DISPOSAL SCHEME FOR THE PHILIPPINE ATOMIC RESEARCH CENTER. Preliminary Report. B. C. Benardo and C. A. Melendres (Philippines. Atomic Energy Commission, Manila). Aug. 1962. 12p.

The problem studied was to devise a system for the management and control of radioactive solid wastes expected to arise at the Philippine Atomic Research Center. A scheme is presented together with the preliminary complement of equipment and facilities needed. Wastes arising are to be classified as low or high level and collected in suitable containers. Low-level wastes will be processed by baling, packaged in wooden crates, and disposed of initially by storage in an underground concrete vault. Ultimate disposal by direct ground burial is contemplated if geologic conditions are favorable. An intensive hydrological investigation of the reactor site is, therefore, proposed. High-level wastes will be packed in concrete shielded drums and disposed of in the concrete storage vault. A room with facilities for treating and packaging the wastes will be provided. (auth)

**29869** (EURAEC-417) PHYSICAL CHEMISTRY OF THE MIGRATION OF THE CATIONS INTO THE GROUND. Special Technical Report. L. Baetsle (Société Belge de Chimie Nucléaire, Brussels). Jan. 1963. Work Performed under United States – Euratom Joint Research and Development Program. Contract 048-61-4RDB. 33p. A translation. (EUR-141.f)

The present studies led to the development of new methods allowing one to follow the variation of the distribution coefficient in a natural ion exchanger occupied with three macroscopic ions. The determination methods of the relative velocities of radioactive cations in soils were investigated comparatively. No definite method has been found for the case of continuous discharge into the ground. For the migration of radio-nuclides in a natural environment the calculation method based on the static distribution coefficient seems to be adequate. The analogy between the hydrodynamic and physico-chemical dispersion is examined in order to determine the relation between the parameters describing the phenomena. Finally some practical cases are presented and discussed. (auth)

**29870** RELATIONSHIP BETWEEN THE PROBLEMS OF RADIOACTIVE EFFLUENT DISCHARGE AND SITOLOGICAL STUDIES. A. Menoux. Bull. Inform. Sci. Tech. (Paris), No. 70, 3-5(Mar. 1963). (In French)

The studies necessary for appreciating the possibilities of a given geographical site for nuclear installations involve a very wide variety of scientific domains concerned with the surroundings (air, water, soil, the human context). These studies are intended to lead to the determination in each case of the diffusion, dilution, or dispersion parameters on the one hand, and of the deposition, absorption, or reconcentration parameters on the other; it is thus possible to predict the course of the radioactive effluents from the moment they leave the installations which produce them up to the moment when they reach the persons who might be exposed to them. During normal operation, the object is to make the best use of the capacity of the surroundings in their role of depository for the diffusion and dispersion of the effluents, while at the same time insuring against the risks of a reconcentration which could upset the balance of the return to humans of the radioactive products released. In the case of an accident, within the limits of the hypotheses made by the installation safety specialists, the object is to estimate the possible consequence of a relatively large emanation of atmospheric effluents or of a discharge of liquid radioactive effluents, in such a way as to calculate the consequences to property and, from a health point of view, to the surrounding populations. (auth)

**29871** THE DISCHARGE INTO THE RHONE OF LIQUID RADIOACTIVE EFFLUENTS FROM THE MARCOULE CENTRE. J. Rodier, J. Scheidhauer, M. Marichal, R. Court, R. Estournel, and F. Gallissian. Bull. Inform. Sci. Tech. (Paris), No. 70, 7-18(Mar. 1963). (In French)

At the Marcoule Center the residual radioactive waters, of which the annual production is about 100,000 $m^3$ containing about 20,000 C, are subjected to physical or chemical treatments intended to retain the major part of the radioelements in the form of sludges stored on the site. The liquids thus treated have a low specific radioactivity and are subsequently discharged into the Rhone. The dilution is maintained at a level consistent with the current standards because of the high flowrate of the river. This dilution is controlled before and after the discharge. The results of this control were used in numerous studies which

contributed to the knowledge of the dilution and evolution of the radioactivity in rivers. (auth)

**29872** STUDY OF A PURIFICATION DEVICE BASED ON MINERAL EXCHANGES WITH A VIEW TO DISCHARGING WEAKLY RADIOACTIVE RESIDUAL LIQUIDS INTO THE GROUND. C. Gailledreau. Bull. Inform. Sci. Tech. (Paris). No. 70, 27-9(Mar. 1963). (In French)

The receptive capacity of a geological formation for radioisotopes can be considerably improved by modifications which lead to the constitution, locally, of perfectly homogeneous columns of minerals. At the same time the minerals produce at less cost a high purification of the radioactive solutions, and this limits the dilution which is finally transmitted to underground. (auth)

**29873** THE DISCHARGE OF RADIOACTIVE WASTE INTO THE SEA. P. Slizewicz. Bull. Inform. Sci. Tech. (Paris), No. 70, 31-7(Mar. 1963). (In French)

The discharge of radioactive waste into the sea, partially connected with the peaceful development of atomic energy, is discussed. The problems of radioactive contamination presented by this technique are reviewed. The various solutions which were adopted by the countries which have chosen this method for the elimination of a part of their radioactive waste are given. (auth)

**29874** STUDIES ON THE CONTAINER FOR DISPOSING RADIOACTIVE WASTES INTO THE SEA. [PART] I. Tadayoshi Sasaki, Seiichi Watanabe, Gohachiro Oshiba, Noboru Okami, and Masahiro Kajihara (Tokyo Univ.). J. Oceanog. Soc. Japan, 19: 16-26(Apr. 1963). (In Japanese)

Investigations were carried out on form, strength, and corrosion resistance of containers for waste disposal in the sea. Three different sizes of mortar containers of cylindrical form were constructed and collapse tests were made. Among the results of the tests the values of wall thickness/mean radius (t/r) against collapse pressure of the three containers were similar. The value of t/r of the cylindrical container corresponding to the critical collapse pressure of 200 kg/cm$^2$ is 0.25. This shows that the cylindrical part of the container will be able to be designed dependent only upon the value of t/r, if the size of the cylinder is not extremely different from that of the body to be tested. From the results of similar experiments on the end-plate of the container it became clear that the container will be able to withstand the hydraulic pressure of 200 kg/cm$^2$, if the end-plate thickness/inner diameter of the cylinder (t/d) is 0.26. Various kinds of metallic materials may be considered to be suitable as metal used in the cover of the container; however, the steel plates of drums are not only economical in using large numbers at a time, but are also used as containers for disposing radioactive wastes. An apparatus capable of reproducing oceanic conditions such as temperature of sea water, dissolved oxygen, and current velocity, was constructed and used in corrosion tests on the steel plates of drums in an artificial sea water. The weight loss by corrosion during 168 days was about $15 \times 10^{-3}$ g/cm$^2$ in conditions, where the temperature of the artificial sea water was 2°C, the dissolved oxygen was 2.65 ml/l and the current velocity was 1.5 cm/sec. It was found that not only is the dissolved oxygen a primary factor in the corrosion of steel plate in artificial sea water, but also the current velocity plays an important role. (P.C.H.)

**29875** ASPECTS OF THE REMOVAL AND TREATMENT OF WASTE WATERS WITH A CONTENT OF RADIOACTIVE SUBSTANCES. Paul Georgescu and Cristian Bratu. Meteorol. Hidrol. Gospodarirea Apelor, 7: 205-8 (1962).

Based on vast bibliographic material, the main aspects of problems relating to the removal and treatment of waste waters with a content of radioactive substances are presented. The characteristics of storage in underground reservoirs, disposal and retention underground, and disposal in soil, sea, oceans, and rivers are also presented. Main purification methods, principally the chemical methods, adsorption and filtration, and several biological treatment methods, as well as the technical and economical characteristics of the various methods of removal and treatment, are mentioned. (Public Health Eng. Abstr., 43: No. 6, June 1963)

**29876** TRANSPORTATION OF RADIOACTIVE POLLUTION BY WATER TO GREAT DISTANCES. A. Van de Vloed (Intercommunal Water Co., Antwerp). Tech. Sci. Munic., 58: No. 2, 55-68(Feb. 1963).

Consideration is given to steps taken to reduce radiopollution from the atomic energy installations at Oak Ridge, Tennessee, and Harwell, England. Standards of safe radionuclide accumulation in water established by the Harwell plant are given, as well as standards proposed by Euratom. The physical, chemical, and biological factors affecting both the accumulation and dispersal of radioactive materials in water are listed. (TCO)

**29877** UNDERGROUND DISPOSAL OF RADIOACTIVE LIQUIDS OR SLURRIES. (to Continental Oil Co.). British Patent 926,821. May 22, 1963. Priority date Sept. 24, 1958, United States.

A method of subterranean disposal of radioactive liquids or slurries in impermeable rock formations is patented. A well is drilled through a suitable rock formation, and the formation is fractured, preferably in a horizontal direction, at a depth to give adequate shielding from the radioactive material to be stored. The fracturing may be performed by any recognized technique or by injecting the radioactive waste fluid at a pressure greater than the formation breakdown pressure. After the radioactive waste is injected into the fracture, a sealing material is injected to seal the waste in the rock formation. To detect leaks from the storage area, check wells are drilled in the same rock formation and equipped with radiation detection devices. If breakthrough occurs at the check well, the check well is sealed in the same manner as the original well. (M.P.G.)

**29878** METHOD OF FIXING ATOMIC WASTES FOR DISPOSAL. Preston Lenell Gant, D'Arcy Adriance Shock, and John Dean Sudbury (to Continental Oil Co.). British Patent 926,822. May 22, 1963. Priority date Dec. 31, 1958, United States.

A method for solidifying liquid radioactive wastes so that movement is prohibited after disposal is patented. Clay minerals, lime, and basic metal hydroxide are added to the waste in specified amounts. The waste is then pumped into a subterranean formation where it solidifies. Details of the treatment and disposal of the wastes are presented. (M.P.G.)

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

| | | |
|---|---|---|
| ä | becomes | ae |
| ö | | oe |
| ø | | oe |
| ü | | ue (except in transliterated Chinese names) |

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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number in that volume. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Published literature (journal article or book) is identifiable by the absence of a report number.

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| 5870 | 17-28834 | Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS |
| 5871 | 17-29093 | Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS |
| 5872 | 17-29331 | Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS |
| 5876 | 17-29399 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 5879 | 17-29332 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| 5884 | 17-29299 | Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS |
| 5887 | 17-29806 | Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS |
| 5891 | 17-29094 | Dep.(mc); $2.60(fs), $0.86(mf) JCL or OTS |
| 5892 | 17-29400 | Dep.(mc); $3.60(fs), $1.28(mf) OTS |
| **AECL–** | **(Canadian)** | |
| 1739 | 17-29866 | See CRER-1146 |
| 1741 | 17-29778 | Dep.; Free(AECL) |
| 1791 | 17-28588 | Dep.; Free(AECL) |
| **AEET-AM–** | **(Indian)** | |
| 31 | 17-29087 | Dep.(mc) |
| **AEET-ANAL–** | **(Indian)** | |
| 5 | 17-28795 | Dep.(mc) |
| 7 | 17-28796 | Dep.(mc) |
| 8 | 17-28797 | Dep.(mc) |
| 9 | 17-28798 | Dep.(mc) |
| 10 | 17-28799 | Dep.(mc) |
| **AEET-CD–** | **(Indian)** | |
| 12 | 17-29490 | Dep.(mc) |
| **AEEW-M–** | **(British)** | |
| 350 | 17-29562 | Dep.; $0.49(BIS); 3s. 6d. (HMSO) |
| **AEEW-R–** | **(British)** | |
| 85 | 17-29824 | Dep.; $0.63(BIS); 4s. 6d. (HMSO) |
| 211 | 17-29825 | Dep.; $0.98(BIS); 7s. (HMSO) |
| 256 | 17-28918 | Dep.; $0.77(BIS); 5s. 6d. (HMSO) |
| 258 | 17-29067 | Dep.; $0.49(BIS); 3s. 6d. (HMSO) |
| 288 | 17-29705 | Dep.; $0.35(BIS); 2s. 6d. (HMSO) |
| **AERE-R–** | **(British)** | |
| 4120 | 17-28864 | J. Nucl. Mater., 8: 307-19(1963) |
| 4122 | 17-29189 | Dep.; $0.77(BIS); 5s. 6d. (HMSO) |
| 4182 | 17-28821 | Dep.; $0.63(BIS); 4s. 6d. (HMSO) |
| 4314 | 17-29865 | Dep.; $0.63(BIS); 4s. 6d. (HMSO) |
| 4358 | 17-29025 | Dep.; $0.25(BIS); 1s. 9d. (HMSO) |
| **AFSWC-TDR–** | **(Non-AEC)** | |
| 63-28 | 17-29190 | $6.60(OTS) |
| **AGN-TP–** | | |
| 42 | 17-29371 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **ANL–** | | |
| 6713 | 17-29826 | Dep.; $0.50(OTS) |
| **ANL-FGF–** | | |
| 396 | 17-29362 | Trans. AIME, 227: 674-8(1963) |
| **APAE–** | **(Misc.)** | |
| 123 | 17-29293 | Dep.(mc); $9.10(fs), $3.47(mf) OTS |
| **ASD-TDR–** | **(Non-AEC)** | |
| 62-594(Pt.II) | 17-29312 | $10.50(OTS) |
| 63-233 | 17-29170 | OTS |
| **AWRE-O–** | **(British)** | |
| 16/63 | 17-28937 | Dep.(mc) |
| 29/63 | 17-29191 | Dep.(mc) |
| **BAW–** | **(Misc.)** | |
| 1271 | 17-29706 | Dep.; $1.50(OTS) |
| **BBC–** | | |
| 118 | 17-29313 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **BM-RI–** | **(Misc.)** | |
| 6255* | 17-29068 | Free (Bureau of Mines) |
| 6259 | 17-29247 | Dep.(mc); $2.60(fs), $0.92(mf) OTS |
| **BMI–** | **(Misc.)** | |
| 1634 | 17-29372 | Dep.; $0.50(OTS) |
| 1637 | 17-29294 | Dep.; $0.75(OTS) |
| **BMI-X–** | | |
| 227 | 17-29279 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 238 | 17-29314 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **BNL–** | | |
| 6340 | 17-29491 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 6348 | 17-28672 | Dep.(mc); $3.60(fs), $1.13(mf) OTS |
| 6401 | 17-28938 | Dep.(mc); $1.10(fs), $0.80(mf) OTS<br>J. Phys. Chem., 67: 923-4(1963) |
| 6422 | 17-28875 | J. Phys. Chem., 67: 853-7(1963) |
| 6460 | 17-29445 | J. Phys. Chem. Solids, 24: 771-7(1963) |
| 6856 | 17-28750 | Proc. Natl. Acad. Sci. U. S., 49: 626-8 (1963) |
| 6993 | 17-29552 | Phys. Rev. Letters, 10: 543-6(1963) |
| 7033 | 17-29492 | Dep.(mc); $6.60(fs), $2.21(mf) OTS |
| 7048 | 17-29192 | Dep.(mc); $2.60(fs), $0.89(mf) OTS |
| 7091 | 17-29638 | Dep.(mc); $3.60(fs), $1.22(mf) OTS |
| 7094 | 17-29385 | Dep.(mc); $3.60(fs), $1.37(mf) OTS |
| **BRB–** | | |
| 60 | 17-29295 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| **BRL–** | **(Misc.)** | |
| 1199* | 17-29563 | |

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|---|---|---|
| **CAPE–** | | |
| 635 | 17-29049 | EM |
| 987 | 17-29050 | EM |
| **CEA–** | **(French)** | |
| 2095 | 17-28800 | Dep.(mc) |
| 2217 | 17-29373 | Dep.(mc) |
| 2239 | 17-29386 | Dep.(mc) |
| 2240 | 17-29037 | Dep.(mc) |
| 2265 | 17-29193 | Dep.(mc) |
| 2267 | 17-29248 | Dep.(mc) |
| 2271 | 17-29194 | Dep.(mc) |
| 2272 | 17-29195 | Dep.(mc) |
| 2275 | 17-29242 | Dep.(mc) |
| 2297 | 17-28673 | Dep.(mc) |
| **CEA-tr–** | **(French)** | |
| A-1308 | 17-28946 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| A-1316 | 17-29233 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| A-1331 | 17-29234 | Dep.(mc); $1.10(fs), $0.80(mf) JCL |
| **CERN–** | **(European Organization for Nuclear Research)** | |
| 63-11 | 17-29315 | Dep.(mc) |
| 63-14 | 17-29493 | Dep.(mc) |
| 63-15 | 17-29494 | Dep.(mc) |
| 63-16 | 17-29639 | Dep.(mc) |
| 63-18 | 17-29387 | Dep.(mc) |
| 63-20 | 17-29495 | |
| 63-21 | 17-29243 | Dep.(mc) |
| **CETIS–** | **(Italian)** | |
| 18 | 17-29708 | See EUR-197.f |
| **CISE–** | **(Italian)** | |
| 94 | 17-29707 | Dep.(mc) |
| 95 | 17-28642 | Dep.(mc) |
| 96 | 17-28778 | Dep.(mc) |
| **CNAM–** | **(Turkish)** | |
| 7 | 17-29564 | Dep.(mc) |
| **CRER–** | **(Canadian)** | |
| 1146 | 17-29866 | Dep.; $0.50(AECL) |
| **CU–** | **(Misc.)** | |
| 220* | 17-29497 | See NEVIS-114 |
| **DASA–** | **(Misc.)** | |
| 1377* | 17-29481 | See RM-63TMP-3 |
| **DEC-Report–** | **(British)** | |
| 201 | 17-29038 | Dep.(mc) |
| **DLCS–** | | |
| 1470108 | 17-29779 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 3360304 | 17-29780 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 3370104 | 17-29781 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 3420105 | 17-29782 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 3430104 | 17-29783 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 3970101 | 17-29784 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 5000563 | 17-29785 | Dep.(mc); $4.60(fs), $1.49(mf) OTS |
| **DMIC–** | **(Non-AEC)** | |
| 182 | 17-29316 | |
| **DP–** | | |
| 821 | 17-29196 | Dep.; $0.50(OTS) |
| **DRI–** | **(Misc.)** | |
| 2090 | 17-29249 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |

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|---|---|---|
| **EUR–** | **(European Atomic Energy Community)** | |
| 133.i | 17-29197 | Dep.(mc) |
| 141.f | 17-29869 | See EURAEC-417 |
| 197.f | 17-29708 | Dep.(mc) |
| 231.d | 17-29388 | Dep.(mc) |
| 236.e | 17-28589 | Dep.(mc) |
| 272.f | 17-29317 | Dep.(mc) |
| **EURAEC–** | | |
| 399 | 17-29300 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 417 | 17-29869 | Dep.(mc); $3.60(fs), $1.19(mf) OTS |
| 643 | 17-29791 | See GEAP-4218 |
| **FTD-TT–** | **(Non-AEC)** | |
| 62-202 | 17-28594 | OTS |
| **FZK–** | **(Non-AEC)** | |
| 9-179 | 17-29833 | See NARF-62-14T |
| **GA–** | **(Misc.)** | |
| 3396 | 17-29786 | Dep.; $1.50(OTS) |
| 3559 | 17-29318 | Dep.; $1.00(OTS) |
| 4138 | 17-29374 | Dep.; $0.75(OTS) |
| **GAMD–** | **(Misc.)** | |
| 2605(Rev.2) | 17-29787 | Dep.(mc); $10.10(fs), $3.95(mf) OTS |
| 3269 | 17-29788 | Dep.(mc); $2.60(fs), $1.10(mf) OTS |
| **GEAP–** | **(Misc.)** | |
| 3726 | 17-29280 | Dep.; $1.25(OTS) |
| 3819 | 17-29709 | Dep.; $2.50(OTS) |
| 3880(Pt.II) | 17-29319 | Dep.; $1.00(OTS) |
| 3932 | 17-29789 | Dep.(mc); $4.60(fs), $1.58(mf) OTS |
| 4083 | 17-29790 | Dep.; $0.50(OTS) |
| 4092 | 17-29710 | Dep.; $2.00(OTS) |
| 4130 | 17-29711 | Dep.; $2.00(OTS) |
| 4202 | 17-29069 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 4218 | 17-29791 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| **GEMP–** | | |
| 23A | 17-29320 | Dep.; $1.00(OTS) |
| 77 | 17-29712 | Dep.; $1.00(OTS) |
| **GEST–** | **(Misc.)** | |
| 2012* | 17-29250 | |
| **GLR–** | | |
| 14 | 17-29076 | See TID-18996 |
| **HR–** | **(Non-AEC)** | |
| 63-264 | 17-29323 | |
| **HW–** | | |
| 61379 | 17-29321 | $1.10(fs), $0.80(mf) OTS |
| 67293 | 17-29117 | $1.10(fs), $0.80(mf) OTS |
| 73288 | 17-29026 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 73404 | 17-29039 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 74677 | 17-29322 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 76526 | 17-29118 | Dep.; $2.75(OTS) |
| 77375 | 17-29155 | Dep.; $1.00(OTS) |
| 77517 | 17-29198 | Dep.; $0.50(OTS) |
| 77638 | 17-29827 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| 77732 | 17-29828 | Dep.; $0.50(OTS) |
| **HW-SA–** | | |
| 2937 | 17-29820 | Dep.(mc); $4.60(fs), $1.58(mf) OTS |
| 2938 | 17-29821 | Dep.(mc); $3.60(fs), $1.13(mf) OTS |
| 3012 | 17-29375 | $2.60(fs), $1.07(mf) OTS |
| 3040 | 17-29376 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 3056 | 17-29119 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |

| Report No. | Abstract No. | Availability |
|---|---|---|
| **IA–** | **(Non-AEC)** | |
| 794 | 17-28860 | J. Inorg. Nucl. Chem., 25: 867-74(1963) |
| 813 | 17-28822 | Dep.(mc) |
| 834 | 17-29496 | Dep.(mc) |
| **IDO–** | | |
| 14316(Suppl.4) | 17-28801 | Dep.; $3.00(OTS) |
| 16856 | 17-29565 | Dep.; $2.25(OTS) |
| 16893 | 17-29713 | Dep.; $1.25(OTS) |
| **INS-R–** | **(New Zealand)** | |
| 19 | 17-29571 | Dep.(mc) |
| **INSJ–** | **(Japanese)** | |
| 55 | 17-29484 | Dep.(mc) |
| **IS–** | | |
| 562 | 17-29040 | Dep.; $1.50(OTS) |
| 649 | 17-29464 | Phys. Rev. Letters, 10: 509-11(1963) |
| **JAERI–** | **(Japanese)** | |
| 1044 | 17-29792 | Dep.(mc) |
| **JPRS–** | **(Non-AEC)** | |
| 19937(p.29-37) | 17-28644 | OTS |
| 19995(p.1-9) | 17-28701 | OTS |
| 20037 | 17-28702 | $0.50(OTS) |
| **JüL–** | **(German)** | |
| 46-PC | 17-29231 | Dep.(mc) |
| 102-ST | 17-29199 | Dep.(mc) |
| 111-RE | 17-29829 | Dep.(mc) |
| 112-RE | 17-29830 | Dep.(mc) |
| 122-RE | 17-29831 | Dep.(mc) |
| 124-RE | 17-29832 | Dep.(mc) |
| **KFK–** | **(German)** | |
| 134 | 17-28823 | Dep.(mc) |
| **KR–** | **(Norwegian)** | |
| 43 | 17-29714 | Dep.(mc); $4.60(fs), $1.55(mf) OTS |
| 44 | 17-29572 | Dep.(mc); $3.60(fs), $1.31(mf) OTS |
| 48 | 17-29324 | Dep.(mc) |
| **LA–** | | |
| 2735(Rev.) | 17-29715 | Dep.; $0.50(OTS) |
| 2871 | 17-29325 | Dep.; $0.50(OTS) |
| **LADC–** | | |
| 5530 | 17-29654 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 5531 | 17-29655 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 5533 | 17-28824 | Dep.(mc); $3.60(fs), $1.40(mf) OTS |
| 5582 | 17-29437 | J. Chem. Phys., 38: 2482-93(1963) |
| 5588 | 17-28853 | J. Chem. Phys., 38: 2105-6(1963) |
| 5785 | 17-29251 | Dep.(mc); $2.60(fs), $0.92(mf) OTS |
| 5786 | 17-29389 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **LAL–** | **(French)** | |
| 1049 | 17-29573 | Dep.(mc) |
| 1050 | 17-29640 | Dep.(mc) |
| **LAMS–** | | |
| 2882 | 17-29390 | Dep.; $1.75(OTS) |
| 2884 | 17-29027 | Dep.; $0.50(OTS) |
| 2904 | 17-29793 | Dep.; $0.75(OTS) |
| 2916 | 17-29656 | Dep.; $1.25(OTS) |
| **LF–** | | |
| 4 | 17-28643 | Dep.; $0.50(OTS) |
| **LNF–** | **(Italian)** | |
| 63/33 | 17-29200 | Dep.(mc) |
| **LR–** | **(Misc.)** | |
| 358(NRCC) | 17-29253 | See NRC-7129 |
| **MCW–** | | |
| 1480 | 17-28779 | Dep.; $0.50(OTS) |
| **MITNE–** | **(Misc.)** | |
| 28* | 17-29794 | Dep.; $1.25(OTS) |
| 34 | 17-29716 | Dep.(mc); $4.60(fs), $1.46(mf) OTS |
| **ML–** | **(Misc.)** | |
| 1038* | 17-29657 | |
| **MND–** | **(Misc.)** | |
| 1123 | 17-29853 | Dep.(mc); $7.60(fs), $2.48(mf) OTS |
| 2584-4 | 17-29854 | Dep.; $1.75(OTS) |
| **MND-P–** | | |
| 3008 | 17-29855 | Dep.(mc); $11.00(fs), $4.52(mf) OTS |
| 3009 | 17-29856 | Dep.(mc); $9.60(fs), $3.65(mf) OTS |
| **MPR-XIII–** | | |
| 5-63 | 17-29075 | See TID-18978 |
| **MR-N–** | **(Non-AEC)** | |
| 300 | 17-29377 | See NARF-63-1T |
| 301 | 17-29378 | See NARF-63-2T |
| **MRL-TDR–** | **(Non-AEC)** | |
| 62-61 | 17-29120 | $3.50(OTS) |
| **MSAR–** | **(Misc.)** | |
| 63-57 | 17-29281 | Dep.(mc); $3.60(fs), $1.19(mf) OTS |
| 63-91 | 17-29252 | Dep.(mc); $4.60(fs), $1.58(mf) OTS |
| **NAA-SR–** | | |
| 8401 | 17-29795 | Dep.; $2.75(OTS) |
| 8422 | 17-28825 | Dep.; $0.50(OTS) |
| **NAA-SR-Memo–** | | |
| 7844 | 17-29717 | Dep.(mc); $8.10(fs), $2.81(mf) OTS |
| 8407 | 17-29796 | Dep.(mc); $8.10(fs), $2.87(mf) OTS |
| 8456 | 17-29718 | Dep.(mc); $1.60(fs), $0.83(mf) OTS |
| 8465 | 17-29028 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 8485 | 17-29797 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 8529 | 17-29719 | Dep.(mc); $5.60(fs), $1.91(mf) OTS |
| **NARF–** | **(Non-AEC)** | |
| 62-14T | 17-29833 | $9.10 (OTS) as AD-409860 |
| 63-1T | 17-29377 | $3.60(OTS) |
| 63-2T | 17-29378 | $3.60(OTS) |
| **NASA-TN–** | **(Misc.)** | |
| D-1844* | 17-29480 | |
| **NBS-TN–** | **(Non-AEC)** | |
| 163 | 17-29201 | $0.25(GPO) |
| **NDL-TM–** | **(Non-AEC)** | |
| 8 | 17-29867 | |
| **NDL-TR–** | **(Non-AEC)** | |
| 47 | 17-29798 | |
| **NEVIS–** | **(Misc.)** | |
| 114* | 17-29497 | |
| **NIRL-R–** | **(British)** | |
| 26 | 17-29641 | Dep. |

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|---|---|---|
| 27 | 17-29642 | Dep.(mc) |
| 31 | 17-29202 | Dep.(mc); $0.35(BIS); 2s. 6d. (HMSO) |
| **HP–** | **(AEC File No. for Non-AEC Reports)** | |
| 12762 | 17-29121 | |
| 12888(Vol.1) | 17-29857 | |
| 12888(Vol.2) | 17-29858 | |
| 12888(Vol.3) | 17-29859 | |
| 12888(Vol.4) | 17-29860 | |
| 12920 | 17-29391 | |
| 12934 | 17-29070 | |
| 12940 | 17-28674 | Dep.(mc) |
| 12941 | 17-28675 | Dep.(mc) |
| 12945 | 17-29498 | Dep.(mc) |
| 12946 | 17-29499 | Dep.(mc) |
| 12947 | 17-29171 | Dep.(mc) |
| 12949 | 17-29122 | |
| 12951 | 17-29392 | Dep.(mc) |
| 12957 | 17-28590 | Dep.(mc) |
| 12958 | 17-28591 | Dep.(mc) |
| **HP-tr–** | **(AEC File No. for Non-AEC Translations)** | |
| 1031 | 17-29177 | OTS |
| 1032 | 17-29333 | Dep.(mc); $4.60(fs), $1.49(mf) JCL |
| 1034 | 17-29662 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| 1035 | 17-28947 | Dep.(mc); $5.60(fs), $1.94(mf) JCL or OTS |
| 1036 | 17-28948 | Dep.(mc); $3.60(fs), $1.13(mf) JCL or OTS |
| 1039 | 17-29401 | Dep.(mc); $2.60(fs), $0.83(mf) JCL |
| **NRC–** | **(Canadian)** | |
| 7129 | 17-29253 | |
| **NRL–** | **(Misc.)** | |
| 5930* | 17-29379 | $1.60(OTS) |
| 5935* | 17-29394 | $1.60(OTS) |
| 5951* | 17-29485 | |
| **NYO–** | | |
| 2483 | 17-29720 | Dep.(mc); $3.60(fs), $1.40(mf) OTS |
| 9717 | 17-29716 | See MITNE-34 |
| 10050 | 17-28676 | Dep.; $2.75(OTS) |
| 10268 | 17-29500 | Dep.(mc); $4.60(fs), $1.70(mf) OTS |
| 10427 | 17-29071 | Dep.(mc); $6.60(fs), $2.03(mf) OTS |
| 10551 | 17-28826 | Dep.(mc); $2.60(fs), $1.10(mf) OTS |
| 10562 | 17-29574 | Dep.(mc); $10.10(fs), $3.92(mf) OTS |
| 10574 | 17-29721 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **OKLA–** | | |
| 2698-1 | 17-29157 | See TID-18981 |
| **ORNL–** | | |
| 3461 | 17-28939 | Dep.; $1.75(OTS) |
| **ORNL-TM–** | | |
| 539 | 17-29282 | Dep.(mc); $3.60(fs), $1.22(mf) OTS |
| 562 | 17-29156 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 606 | 17-29172 | Dep.(mc); $1.60(fs), $0.83(mf) OTS |
| 609 | 17-29799 | Dep.(mc); $3.60(fs), $1.31(mf) OTS |
| 612 | 17-29123 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 625 | 17-28919 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **ORO–** | | |
| 491 | 17-29124 | Dep.(mc); $3.60(fs), $1.37(mf) OTS |
| **OTS–** | **(Misc.)** | |
| 63-31160(p.29-37)* | 17-28644 | See JPRS-19937(p.29-37) |
| 63-31185(p.1-9)* | 17-28701 | See JPRS-19995(p.1-9) |
| 63-31211* | 17-28702 | See JPRS-20037 |
| **PAEC(A)IH–** | **(Philippines)** | |
| 631 | 17-28592 | Dep.(mc) |
| 632 | 17-28593 | Dep.(mc) |
| **PAEC(D)CH–** | **(Philippines)** | |
| 634 | 17-28920 | Dep.(mc) |
| 635 | 17-28921 | Dep.(mc) |
| 636 | 17-28922 | Dep.(mc) |
| **PAEC(D)HP–** | **(Philippines)** | |
| 622 | 17-29868 | Dep.(mc) |
| **PAN–** | **(Polish)** | |
| 108/Doz. | 17-29834 | Dep. |
| 242 | 17-29575 | Dep. |
| 405/IX | 17-29835 | Dep. |
| 406/XII | 17-29836 | Dep. |
| 409/IX | 17-29722 | Dep. |
| 410/IX | 17-29576 | Dep. |
| 413(XII) | 17-29837 | Dep. |
| 418/XII | 17-29723 | Dep. |
| 420/XI | 17-29838 | Dep. |
| 423/Doz. | 17-29839 | Dep. |
| 424/XI | 17-29840 | Dep. |
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| **PB–** | **(Non-AEC)** | |
| 181458 | 17-29296 | $0.75(OTS) |
| **PG-Report–** | **(British)** | |
| 433 | 17-28802 | Dep. |
| **Q–** | **(Misc.)** | |
| B2089-1* | 17-29245 | See AD-406688 |
| **R–** | **(Misc.)** | |
| 366* | 17-29497 | See NEVIS-114 |
| **RIB–** | | |
| 45 | 17-29173 | Dep.(mc); $4.60(fs), $1.61(mf) OTS |
| **RM–** | **(Misc.)** | |
| 63-TMP-3* | 17-29481 | $13.00 (OTS) as AD-409859 |
| 3089-PR* | 17-29724 | |
| 3364-PR* | 17-29658 | |
| **RME–** | | |
| 4541 | 17-29088 | Dep.; $0.50(OTS) |
| 4542 | 17-29089 | Dep.; $0.50(OTS) |
| 4549 | 17-29090 | Dep.; $0.50(OTS) |
| **RT-CHI–** | **(Italian)** | |
| (63)17 | 17-28817 | p.285-91 of "Proceedings of 1961 International Symposium on Microchemical Techniques." Rome, J. Wiley & Sons, Inc., 1963 |
| **RT-EL–** | **(Italian)** | |
| (63)4 | 17-29725 | Dep.(mc) |
| **RT-FI–** | **(Italian)** | |
| (63)12 | 17-29800 | Dep.(mc) |
| **RT-GEO–** | **(Italian)** | |
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| **RT-ING–** | **(Italian)** | |
| (63)6 | 17-29726 | Dep.(mc) |
| (63)7 | 17-29072 | Dep.(mc) |
| **RTI–** | | |
| 2513-T10 | 17-29124 | See ORO-491 |
| **SC–** | **(Misc.)** | |
| 4799(M) | 17-29084 | Dep.(mc); $9.60(fs), $3.74(mf) OTS |
| **SCL-T–** | | |
| 483 | 17-28835 | Dep.(mc); $7.60(fs), $2.39(mf) JCL |
| 486 | 17-28836 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| **SCPRI(A)–** | **(French)** | |
| 87 | 17-29125 | Dep.(mc) |
| **SCTM–** | | |
| 130-63(74) | 17-29254 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **SL–** | **(Misc.)** | |
| 1998 | 17-29801 | Dep.(mc); $14.00(fs), $6.23(mf) OTS |
| **SLAC–** | | |
| 16 | 17-29643 | Dep.; $2.25(OTS) |
| **SSD-TDR–** | **(Non-AEC)** | |
| 63-72 | 17-29659 | $4.60(OTS) |
| **STI-PUB–** | **(International Atomic Energy Agency)** | |
| 21/9 | 17-28768 | $8.00, Sch. 168, 48s. stg, NF 32, DM 28 (IAEA) |
| 65 | 17-28625 | $9.00, Sch. 189, 54s. stg, NF 36, DM 31.50 (IAEA) |
| **TDR–** | **(Non-AEC)** | |
| 169(3210-05)TN-2 | 17-29659 | See SSD-TDR-63-72 |
| **TEE–** | **(Non-AEC)** | |
| 7002-8 | 17-29391 | See NP-12920 |
| **TID–** | | |
| 11597 | 17-29802 | Dep.(mc); $8.60(fs), $3.05(mf) OTS |
| 11599 | 17-29803 | Dep.(mc); $4.60(fs), $1.58(mf) OTS |
| 16839 | 17-28931 | J. Phys. Chem., 67: 694-6(1963) |
| 17080 | 17-29393 | Dep.(mc); $2.60(fs), $0.89(mf) OTS |
| 17092 | 17-28873 | J. Phys. Chem., 67: 762-9(1963) |
| 17097 | 17-29085 | $2.60(fs), $1.04(mf) OTS |
| 17120 | 17-29126 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 17132 | 17-28940 | Dep.(mc); $2.60(fs), $1.04(mf) OTS |
| 17133 | 17-29326 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| 17148 | 17-28677 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 17149 | 17-28827 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 17152 | 17-29395 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 17162 | 17-29073 | Dep.(mc); $3.60(fs), $1.31(mf) OTS |
| 17163 | 17-29074 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| 17257 | 17-29283 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
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| 18634 | 17-29127 | Dep.(mc); $8.60(fs), $3.20(mf) OTS |
| 18707 | 17-29232 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 18904 | 17-29397 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 18904 | 17-28941 | Dep.(mc); $3.60(fs), $1.16(mf) OTS |
| 18905 | 17-28942 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 18936 | 17-28678 | Dep.(mc); $6.60(fs), $2.06(mf) OTS |
| 18947 | 17-29396 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 18948 | 17-29244 | Dep.(mc); $5.60(fs), $1.85(mf) OTS |
| 18949 | 17-28679 | Dep.(mc); $2.60(fs), $0.86(mf) OTS |
| 18951 | 17-28828 | Dep.(mc); $3.60(fs), $1.40(mf) OTS |
| 18952 | 17-29284 | Dep.(mc); $2.60(fs), $1.07(mf) OTS |
| 18953 | 17-29091 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 18954 | 17-28680 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 18956 | 17-29297 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 18959 | 17-28829 | Dep.(mc); $2.60(fs), $0.86(mf) OTS |
| 18960 | 17-29174 | Dep.(mc); $2.60(fs), $1.04(mf) OTS |
| 18961 | 17-28943 | Dep.(mc); $9.10(fs), $3.35(mf) OTS |
| 18967 | 17-29727 | Dep.(mc); $4.60(fs), $1.70(mf) OTS |
| 18970 | 17-29041 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 18975 | 17-29804 | Dep.(mc); $2.60(fs), $1.07(mf) OTS |
| 18976 | 17-28923 | Dep.(mc); $5.60(fs), $1.97(mf) OTS |
| 18978 | 17-29075 | Dep.(mc); $3.60(fs), $1.13(mf) OTS |
| 18979 | 17-28599 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 18980 | 17-28681 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 18981 | 17-29157 | Dep.(mc); $2.60(fs), $0.89(mf) OTS |
| 18983 | 17-28944 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 18985 | 17-28830 | Dep.(mc); $9.10(fs), $3.29(mf) OTS |
| 18992 | 17-28682 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 18995 | 17-28924 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 18996 | 17-29076 | Dep.(mc); $2.60(fs), $0.86(mf) OTS |
| 18998 | 17-29327 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 19001 | 17-29841 | Dep.(mc); $2.60(fs), $1.01(mf) OTS |
| 19003 | 17-28683 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19007 | 17-29328 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 19008 | 17-29158 | Dep.(mc); $4.60(fs), $1.64(mf) OTS |
| **TRG-Inf. Ser.–** | **(British)** | |
| 288 | 17-29043 | Dep.; $1.60(fs), $0.80(mf) JCL |
| 301 | 17-29077 | Dep.; $1.10(fs), $0.80(mf) JCL or OTS |
| 314 | 17-29807 | Dep.; $1.60(fs), $0.80(mf) JCL |
| **UAC–** | | |
| 6705 | 17-29126 | See TID-17120 |
| 6710 | 17-28873 | See TID-17092 |
| 6718 | 17-29395 | See TID-17152 |
| 6733 | 17-28677 | See TID-17148 |
| 6738 | 17-29085 | See TID-17097 |
| 6775 | 17-29326 | See TID-17133 |
| 6823 | 17-29074 | See TID-17163 |
| 6824 | 17-29073 | See TID-17162 |
| 6905 | 17-28972 | See TID-17448 |
| 6908 | 17-28880 | See TID-17494 |
| 7088 | 17-29428 | See TID-17879 |
| **UCLA–** | | |
| 513 | 17-29128 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **UCRL–** | | |
| 6886 | 17-29203 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 6892 | 17-29398 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7007 | 17-29728 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| 7063 | 17-29577 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 7083 | 17-29660 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 7123 | 17-29337 | Acta Met., 11: 861-6(1963) |
| 7124 | 17-29338 | Acta Met., 11: 867-71(1963) |
| 7135-T | 17-28970 | J. Chem. Phys., 38: 2588-9(1963) |
| 7145 | 17-29805 | Dep.; $2.25(OTS) |
| 7179 | 17-29132 | See UCRL-7254(p.16-27) |
| 7193 | 17-29131 | See UCRL-7254(p.6-16) |
| 7254 | 17-29129 | Dep.; $1.25(OTS) |
| 7254(p.6-16) | 17-29131 | |
| 7316 | 17-29092 | Dep.; $0.75(OTS) |
| 8030(Rev. Apr.'63, Ed.) | 17-29501 | Dep.; $0.75(OTS) |

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| 10256 | 17-29204 | Dep.(mc); $2.60(fs), $0.86(mf) OTS<br>Nucl. Instr. Methods, 23: 109-16(1963) |
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| 10492 | 17-29502 | Dep.(mc); $6.60(fs), $2.06(mf) OTS |
| 10515 | 17-29339 | Acta Met., 11: 881-98(1963) |
| 10641 | 17-29542 | Phys. Letters, 5: 63-7(1963) |
| 10650 | 17-28831 | Dep.; $1.50(OTS) |
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| 10655 | 17-29645 | Dep.; $0.50(OTS) |
| 10683 | 17-28685 | Dep.; $2.75(OTS) |
| 10753 | 17-29545 | Phys. Letters, 5: 75-6(1963) |
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| 10755 | 17-29329 | Dep.; $1.50(OTS) |
| 10762 | 17-29503 | Dep.; $1.50(OTS) |
| 10790 | 17-29554 | Phys. Rev. Letters, 10: 550-1(1963) |
| 10800 | 17-29661 | $1.60(fs), $0.80(mf) OTS |
| 10809 | 17-29553 | Phys. Rev. Letters, 10: 546-9(1963) |
| 10834 | 17-29504 | Dep.; $2.00(OTS) |
| 10894 | 17-29505 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |

| Report No. | Abstract No. | Availability |
|---|---|---|
| **UCRL-Trans-** | | |
| 958 | 17-28837 | Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS |
| **UNC-** | **(Misc.)** | |
| 5055 | 17-29298 | Dep.(mc); $6.60(fs), $2.03(mf) OTS |
| 5056 | 17-29330 | Dep.(mc); $4.60(fs), $1.61(mf) OTS |
| **USNRDL-TR-** | **(Non-AEC)** | |
| 639 | 17-29138 | $7.60 (OTS) as AD-410319 |
| 641 | 17-28699 | |
| 644 | 17-28700 | |
| 645 | 17-29139 | $2.60 (OTS) as AD-410413 |
| 648 | 17-28945 | |
| **WAPD-T-** | | |
| 1563 | 17-29566 | Dep.(mc); $2.60(fs), $0.83(mf) OTS |
| 1577 | 17-29567 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **ZFK-WF-** | **(German)** | |
| 13 | 17-29255 | Dep.(mc) |